THE GLASS INDUSTRY

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GLASS DIVISION MEETS AT CONNEAUT LAKE PARK

The Glass Division of the American Ceramic Society held its annual Fall Meeting at Conneaut Lake Park, Pa., September 12 and 13. There were two half-day sessions of committee reports and technical papers, a golf tournament and an informal dinner. Many of the 100 registrants arrived on Thursday evening, and remained for the closing dinner and final conversations Saturday night. Friday forenoon provided time for more arrivals, much hand-shaking and talk, registration, and practice rounds of golf.

Francis C. Flint opened the Friday afternoon session with a report from his group of lexicographers. Although the definition of glass formulated by Committee C-14-I had been adopted as tentative by vote of the larger Committee, it could not be considered as in final form, particularly as to its second portion, dealing with classification of glasses. Discussion from the floor brought out some of the contingent problems and criticisms, particularly in connection with the naming and classification of the commercial glasses.

However, it seems likely that our favorite material will soon be defined, by those who know it best, in language both rigid and satisfying.

On motion of Mr. Burch, seconded by Mr. Schurtz, the Division went on record as approving the first sentence of the definition:

"Glass is an inorganic product of fusion which has cooled to a rigid condition without crystallizing."

Further description, qualification, and characterization are to be formulated before the definition is ready for the vote of A. S. T. M. on final adoption as a standard. Reprints of the tentative definition, and of the other tentative standards, were distributed by Louis Navias, secretary of Committee C-14.

Cove Point, summer home of Mr. Flint, has been shown by W. R. Lester to possess material qualifications as a fitting birthplace of the Summer Session. Using beach sand, wood ashes, and oyster shells, he assembled the necessary silica, alkali, and lime, and made "Cove Point Glass." A polished lens of this glass, backed by a miniature bulb, crowned the lighthouse," and around this were grouped tube samples of the materials, arranged on a souvenir plaque presented to Mr. Flint. The stunt was greeted by laughter and applause, before the Division turned to more serious matters.

Some idea of the educational work necessary to convince pharmacists about what can and cannot be done for them came out in the report of F. C. Flint, chairman of our committee on Light-Protective Glasses for Pharmaceutical Purposes. Wave lengths, absorptions, thicknesses, and Angström (pronounced "Awngstrum"—ask Ole Olson) units have been tossed at the druggists until they begin to see the light, or at least begin to see how much ultra-violet light can be stopped if a bottle is to retain mentionable transparency. The development of this sincere liaison with some of our most important and exacting customers is evidently coming along nicely, under the diplomatic direction of Mr. Flint.

Mr. E. L. Hettinger, Willson Products, Inc., staged several interesting demonstrations. Using a "black-body" bulb and a simple millivoltmeter, he showed how the radiant energy from an ordinary incandescent bulb could be adjusted so as to produce a 100 reading on the instrument. Then, by interposing panes of glass of various colors, he showed how some of the comparatively light-colored iron-bearing glasses reduce this radiant energy by more than 90 per cent, while some of the blue and amber glasses, albeit much darker, exhibit much less heat absorption. The importance of heat-stopping goggles, especially in the production of the millions of tons of steel needed for the current defense program, was stressed by Mr. Hettinger as one of the glassmaking problems now facing the technologists.

Forsaking his sawed-off air rifle of Lake Keuka memory, Mr. Hettinger showed how his lung power has been developed by conversation on the harmonic-vibration breakage of glass. Using steel pellets and a metal tube, he blew these sharpened missiles against glass bottles with different impacts, and produced all types of injury, from faint surface scars to forking cracks and complete punctures. He insists that the breakage is the result of high-frequency vibrations and not of simple impacts, and the members did not argue against him very successfully.

In the evening, the talk by Mr. Alfred Paulus of Westinghouse, illustrated by animated cartoons in color showing the destruction of a horde of bacteria by the "Sterilamp," and other moving pictures showing the application of these lamps in hospitals, air-conditioning, and food preservation and packing, furnished a highly interesting and informative hour. Actual "Sterilamp" units were exhibited.

Prizes for the evening bridge game, consisting of a beautiful crystal glass cigarette box and a flameware tea pot, were presented by the Corning Glass Works. Four tables were formed, and sharp competition took place. First prize was won by Joseph Keaney and Harold Haf-

A.C.S. MEETING

The highlights of the two-day session at Conneaut Lake as scened by the cameras of E. L. Hettinger and J. R. Hostetter.

Terrace entrance to the Hotel Conneaut with some of the glassmen waiting for the discussions to start.

Unscheduled discussion.

Sun and fair weather was enjoyed between sessions.

A. Herman of Seagram's Fred Dixon of Gunite life easy.

The boardwalk rail was a popular sunning place.

The ladies play bridge.

Valet service was at premium as ald Lester and Fred Dixon found

K. B. McAlpine and a new friend.

T. C. Baker presenting his paper on water hammer breakage.

Alfred Paulus of Westinghouse lectured on virtues of Sterilamps.

Chester Austin talks on selenium ruby glass.

Frank Day, Jr., presenting his p on decolorizing glass.

Hurd Stafford ad- the meeting.

Francis Flint receiving the plaque of Cove Point Glass.

The informal glass division dinner.

N. S. Garbisch and E. W. Tillotson with their heads together.

Newsman John Hostetter relaxing after the dinner.

A. Pincus, J. C. Hostetter, Robert Curts and Francis Williams ride the Erie.

A group of delegates gather in the "cloak room."

The pin-ball machine paid its own way while the glassmen lost on side bets.

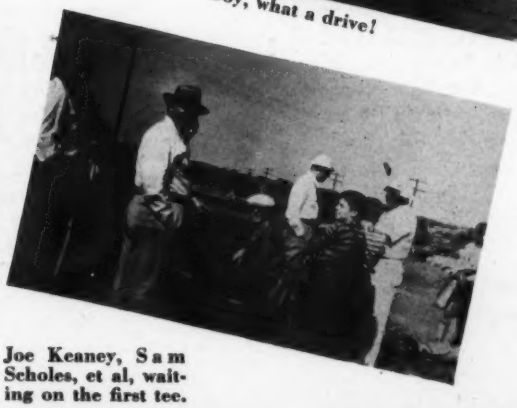
"Saluté," by Fred Dixon, Jr.

"Doc" Shively and Joe Greene.

"Len" Ghering getting ready for the golf tournament.

Boy, what a drive!

One of Hettinger's lake scenes. Watch for it again.



Joe Keaney, Sam Scholes, et al, waiting on the first tee.

ner was second. Two of the ladies were successful in acquiring low scores, and were consoled by the gift of Willson sun goggles.

The effectiveness of high-speed photography in demonstrating glass casualties was brought out in some splendid moving pictures presented by T. C. Baker, Hartford-Empire Company. When a bottle, partly filled with water, especially when a partial vacuum exists above the liquid, is jarred or violently shaken up and down, "cavitation" or the formation of vacuum bubbles takes place. When this vacuole collapses and the water strikes the bottom of the bottle with an explosive slap, cracks may result. This exceedingly rapid action, arrested in mid-flight by the camera, could be clearly seen in these remarkable movies. Selected frames were presented as slides for more detailed study. The next time we see a carton or case of filled bottles set down ungently, we shall be able to imagine what is going on inside.

That volatile and elusive element, selenium, and its behavior in the production of selenium ruby glass was the subject of a paper by Sullivan and Austin, presented by Chester A. Austin of Battelle Memorial Institute. These men have done much painstaking work in the careful compounding and melting of batches for ruby as well as in the analyses of their products so as to demonstrate favorable conditions for the retention of selenium and for the production of the cadmium sulfide-selenium ruby. We may well hope for the early publication of this excellent article.

Frank Day, Jr., University of Pittsburgh, gave the paper by Day and Silverman on the chemistry of selenium decolorizing. Their conclusions, predicated chiefly on the form of the absorption curves of their glasses, do not agree with earlier speculations, and indicate that definite chemical reactions between selenites and the iron oxides are responsible for the disappearance of the iron green. Simpler concepts based on the idea of mere complementary absorptions seem to be slated for the discard in view of a much more complex chemistry. This paper is another distinct contribution to the technology of glass coloration.

Hurd W. Safford, also of Pitt, gave a very clear exposition of the views of Safford and Silverman on the alumina-silica relationship in glass. The argument seems to be that aluminum, by virtue of its habit of 4- or 6-fold coordination with oxygen, behaves much like silicon, although these investigators deny that alumina is a real glass-former like silica. Discussion brought out evidence of glassy aluminates produced at the Geophysical Laboratory, and mention was made of the fact that the large improvement in the durability of glasses as a result of relatively small additions of alumina can scarcely be explained merely on the basis of a similarity between the lattice arrangements attributed to the two elements.

Dr. J. T. Littleton, who is recovering at his home from injuries sustained in an automobile accident, sent his personal and official greetings to the Division. The Secretary was instructed to reply, expressing the regret of the Division that this member of our "old guard" could not be present.

On Saturday afternoon the golfing members participated in a competition, based on match play against par under three-fourths handicap, for the O. Hommel trophy. This beautiful plaque was won by Chester Treischel, R. T. Vanderbilt Co., who came in only three down to par, in a field of 22 competitors. Armand L. Houze, Jr., four down, was second; C. E. Grigsby and F. S. Stump, six down, tied for third; and F. W. Dixon, seven down, was fifth. Willson sun glasses provided consolation prizes for these runners-up. The establishment of suitable bridge-heads at the numerous creeks and ditches required heavy and continuous firing.

Report of Committee on Nomenclature and Discussion of "Definition of Glass." *By F. C. Flint, Hazel-Atlas Glass Company. (Chairman of Sub-Committee I, A.S.T.M., committee C-14)*

After about two years of correspondence on the subject of the "definition of glass" the members of this sub-committee met at Cove Point, Md., on April 24 and 25 and formulated a definition of glass which incorporated the various ideas developed through the correspondence. The definition as finally drawn up follows:

"Glass is an inorganic product of fusion which has cooled to a rigid condition without crystallizing. Some glasses contain non-glassy material, always embedded in a glassy matrix. Glasses may be colored by suitable material in a dissolved or dispersed condition

"Glasses may be classified as:

A. One-component glasses, consisting of single oxides, such as silica, (SiO_2), boric oxide, (B_2O_3), or phosphoric oxide, (P_2O_5).

B. Two-component glasses, of which the chief commercial representatives are the soluble silicates.

C. Multi-component glasses:

1. Soda-lime-silica glasses, which include the great bulk of commercial glassware.

2. Borosilicate glasses, which range from soda-lime-silica glasses containing small amounts of boric oxide to low-expansion glasses containing little or no soda or lime.

3. Special glasses:

(a) "Flint" glasses, containing lead oxide, (PhO), ranging from lead tubing and cut glass, to heavy lead glasses used for optical instruments and imitation jewelry.

(b) Optical glasses, mostly silicate or borosilicate glasses distinguished by physical perfection and a wide range of optical properties.

(c) Non-silicate glasses, used for special purposes, and at present of limited commercial applicability."

This definition was submited to the entire membership of A.S.T.M. Commitee C-14 for vote. The vote was affirmative and the definition has been submitted for publication as a tentative definition.

In the discussion of the definition various criticisms and suggestions were made. These will be gone over by the members of sub-committee I and the definition revised if it is found to be necessary.

Report on the A.S.T.M. Committee Work or "Standards." *By Dr. Louis Navias, General Electric Co. (Secretary, A.S.T.M. Committee C-14).*

The committee has recommended that the following methods be continued as tentative for another year:

Tentative Methods of:

Chemical Analysis of Glass Sand (C146-39T)

Hydrostatic Pressure Test on Glass Containers (C147-40T)

Polariscopic Examination of Glass Containers (C148-40T)

Thermal Shock Test on Glass Containers (C149-40T)

Flexure Testing of Glass (C158-40T)

Report of Sub-Committees

Sub-committee I on Nomenclature and Definitions (F. C. Flint, Chairman). This report was given as a separate paper.

Sub-committee II on Chemical Analysis (G. E. F. Lundell, Chairman). This committee has completed its work on the preparation of referee and routine methods for the chemical analysis of soda-lime glass. The methods have been accepted by the A.S.T.M. as tentative standards and will be published under the serial number C169-41T.

Sub-committee III on Chemical Properties (F. W. Adams, Chairman). As a result of several meetings at which pertinent papers were read, new tentative methods are being developed on the subject of chemical durability. These methods should be ready for trial within the next few months.

Sub-committee IV on Physical and Mechanical Properties (J. T. Littleton, Chairman). This sub-committee is now considering further work on a method for determining the thermal endurance of glass. The shape of the test specimen is being given much consideration and such shapes as blown articles, drawn rods and fibres, plates and marbles are being studied by several laboratories.

Sub-committee V on Thermal Properties (E. W. Tillotson, Chairman). No projects have been submitted to this sub-committee for immediate action.

Sub-committee VI on Glass Construction Block and Tile (J. P. Staples, Chairman). The committee has been busy with tests on individual glass block, on panels of glass block and on mortars used with these blocks. This program has been in progress for several years and will lead to some important specifications and methods.

Report of Committee on Light Protective Glasses for Pharmaceutical Work. *By F. C. Flint, Hazel-Atlas Glass Company (Chairman of U.S.P. Glass Advisory Board).*

Several years ago, at the request of the U.S.P. revision committee a glass advisory board was formed, the purpose of which was to assist the U.S.P. committee in all problems concerning the technical side of glass packaging. During the past year this board has been particularly active and has been assisting the U.S.P. group on the problem of light protection of pharmaceutical packages. The membership of the board working on this problem consists of the following:

F. C. Flint, Chairman
G. D. Beal, Mellon Institute, Chairman from the U.S.P.
U. E. Bowes, Owens-Illinois Glass Co.
F. S. Brackett, National Institute of Health
A. N. Finn, National Bureau of Standards
W. R. Lester, Maryland Glass Corp.
J. T. Littleton, Corning Glass Works
K. C. Lyon, Armstrong Cork Co.
E. D. McAlister, Smithsonian Institute
D. E. Sharp, Hartford, Empire Co.
E. W. Tillotson, Mellon Institute

Two meetings have been held during the past year and have resulted in a definition and specification of a light protective glass. This specification is being considered by the U.S.P. committee. Future work will consist of assisting the U.S.P. group in the development of standard testing procedures for measuring the light transmission of glasses and for determining the effect of light on pharmaceuticals.

The U.S.P. committee is also interested in the subject of glass durability and in the near future a glass advisory board consisting of those interested in this problem will be selected.

Water Hammer Breakage in Glass Containers. *By T. C. Baker, Hartford-Empire Co.*

While assisting a large packer in determining the cause of a very small but annoying breakage loss it was found that the particular type of breakage being encountered could be duplicated if a carton packed with filled containers was dropped on another similarly packed carton especially when the carton being struck could move slightly, a condition which is satisfied when the carton is propped up on one end. The breakage takes place in the struck carton. High speed movies which have been taken of this system of events indicates that a water hammer is formed. Measurement of the forces involved show that the forces developed by the water hammer are fairly low. It has also been found that while the water hammer effect is taking place bubbles form in the liquid and that the collapse of these bubbles create a "pick" effect on the sides and bottom of the container. This "pick" effect causes the development of checks in the glass surface which when coupled with the water hammer cause the fracture of the container. The local pressures involved during the "pick" effect have been estimated to be in the neighborhood of 20,000 psi.

Selenium Ruby Glass. *By John D. Sullivan and Chester A. Austin, Battelle Memorial Institute.*

From the results of previous investigations on the production of selenium ruby glass it has been fairly well established that the ruby-red color is due to a precipitated compound which contains selenium, cadmium and sulphur. In the present work methods of retaining these three colorants in the melt during the melting and firing operations was the subject of investigation.

In general, the procedure used consisted of adding the colorants and the various materials under investigation to a base soda-lime-silica glass batch. Melts were then made in both crucibles and in a day tank under controlled atmospheres and standard temperatures. Chemical analysis of the various melts were made and the amount of selenium, cadmium and sulphur retained in the glasses determined.

The results obtained confirmed the known fact that oxidizing conditions are conductive to high selenium losses and that even under a reducing atmosphere the loss of selenium in tank melting is much greater than the loss in pot melting.

To retain sufficient selenium in the glass for the development of a ruby color it is therefore necessary to use reducing agents in the batch. It was shown that while various forms of carbon, when present in the batch, were able to hold very large amounts of selenium in the melt a red color was not produced because the carbon being a strong reducing agent caused the elimination of nearly all of the cadmium. In addition the carbon containing reducing agents tended to discolor the glass giving it in most cases a brownish cast. It was pointed out by the author that in much of the previous work by other investigators the failure to obtain ruby colors has not been due to a loss of selenium but has been due to the loss of cadmium by the use of too slowly reducing conditions.

Of the various reducing agents tried metallic silicon showed the most promise. The use of this material in very small amounts (0.05 per cent in a batch containing 1.0 per cent Se and 0.6 per cent CdS) caused the retention of a sufficient quantity of Se, Cd and S in the final melt.

It was also shown that satisfactory ruby glasses could be produced with selenium contents as low as 0.03 or 0.04 per cent. The minimum amount of cadmium that must be present in the glass in order to obtain the ruby color was found to be in the neighborhood of 0.06 per cent. It was also found that a zinc containing glass is not necessary for the production of a selenium ruby in continuous tanks but that a satisfactory color could be produced with a soda-lime-silica glass containing 0.03 per cent selenium, 0.06 per cent cadmium and 0.03 per cent sulphur.

The Chemical Mechanism of Decolorizing Glass with Selenium. *By Frank Day, Jr., and Alexander Silverman, University of Pittsburgh.*

When small amounts of selenium are added to a glass in the absence of cadmium and sulphur and the glass melted under neutral or slightly oxidizing conditions a pink tint results which lessens the intensity of the green color due to iron. This is the fundamental principle involved in the decolorization of glass. Previous workers have explained this effect by postulating the formation of a red ferrous selenide compound, for example, Gooding and Murgatroyd believe that the following reaction takes place:

$$2\,Se + Fe_2O_4 \rightleftarrows 2\,FeSe + Fe_2O_3 + O_2$$
(blue) (red?)

(*Continued on page* 449)

WATER HAMMER BREAKAGE IN GLASS CONTAINERS*

By T. C. BAKER

Hartford-Empire Company

Abstract

Water hammer breakage of glass containers may occur whenever a heavy object is dropped a few feet upon a packed carton placed so as to permit a short downward movement of the jars. This commonly occurs when one carton is dropped upon another in loading and stacking. When the top of the carton is struck, the jar is suddenly accelerated, forming cavities between the contents and the bottom of the jars and compressing the gases in the headspace, thus imparting a velocity to the contents, and finally causing the contents to overtake the bottom of the jar with a sharp impact. This impact consists of two phenomena: one is a moderate hydrostatic pressure of 35 to 250 lbs./sq. in. which is at a maximum at the bottom and tapers off to the headspace pressure at the top of the contents; the other phenomenon is an intense local pressure of 50,000 lbs./sq. in. to 500,000 lbs./sq. in. developed by the high velocity of the water at the point where the cavities collapse. Combinations of these two phenomena produce nine characteristic fracture patterns which usually can be easily distinguished from other types of breaks.

Water hammer breakage has caused difficulty in catsup, grape juice and baby food containers, and there is little doubt that it occurs occasionally in most light-weight vacuum packed ware. The breakage is usually small, seldom exceeding 0.1 per cent. However, it is annoying because the foods spill out, ruining the appearance of the carton and the labels on the other jars.

Accurate tests on the water hammer strength of jars are difficult because several factors, including the testing machine, the nature and location of adventitious flaws in the glass, and the nature of the contents, can seriously influence the results.

Water hammer breakage may be reduced by prevention of common flaws in the glass, more careful handling of the cartons, proper design of bottle, and carton, upside down packing if practicable, and moderate changes in consistency of liquid contents, or of headspace pressure. Attention to one or more of these matters, with combined efforts by the glass manufacturer and glass packer, can easily reduce this breakage to a satisfactory level.

Fig. 1. Demonstrating water hammer breakage in cartons by dropping one carton upon another.

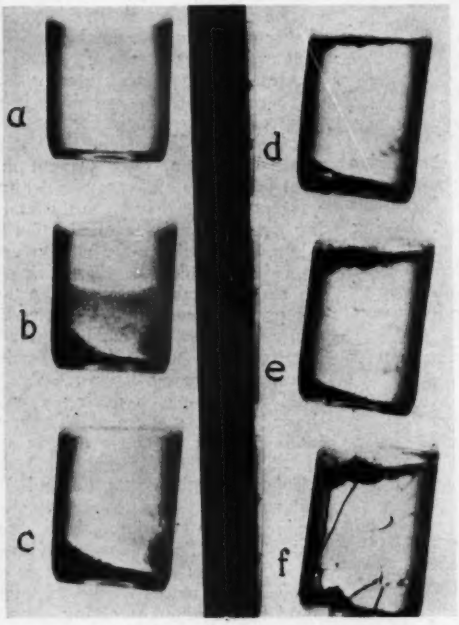


Fig. 2. Water hammer breakage. Successive stages at 1/1200 second intervals. Contents at atmospheric pressure.

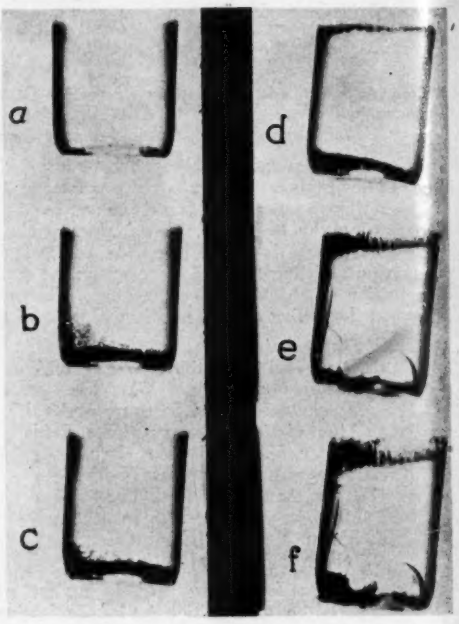


Fig. 3. Water hammer breakage. Successive stages at 1/1200 second intervals. Contents at atmospheric pressure.

In November 1939 a large food packing company asked the Hartford-Empire Company to look into a special problem of breakage occurring in cartons of glass-packed products. The breakage was exceedingly low, being less than 0.1 per cent. However, the annoyance due to the breakage was great owing to the fact that it took place in the cartons and the foods spilled out, making rather a bad mess. Moreover, the breakage was usually not immediately discovered, so that the food spoiled, leaving a disagreeable molding mass to be discovered by the unfortunate person who opened the carton.

The situation was brought to a head when the distributors returned a few carloads to the warehouses. It then became necessary for the warehouses to inspect every jar before shipment. Since the added breakage in shipment from the warehouse to the distributor was rather small, the situation was temporarily relieved, except for the fact that the labor cost of inspection and repacking was exceedingly high.

*Presented at the Glass Division, American Ceramic Society Meeting, Conneaut Lake Park, Pennsylvania, September 13, 1941.

This paper will be published in three sections. This section is introductory and includes the preliminary investigation of the problem. The other two sections will appear in the November and December issues of THE GLASS INDUSTRY.

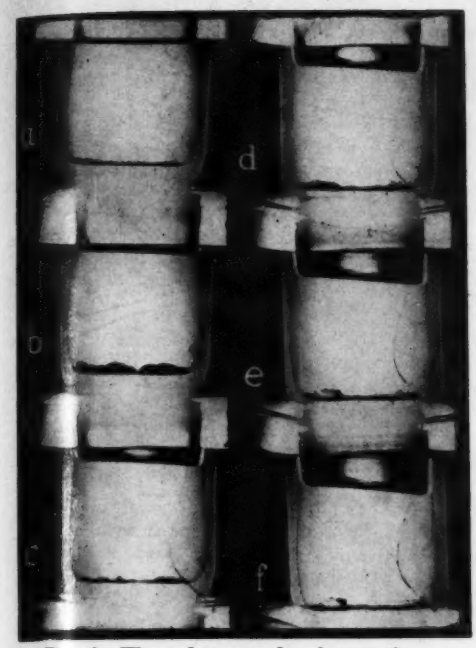


Fig. 4. Water hammer breakage. Successive stages at 1/1200 second intervals. Contents at atmospheric pressure. (The crack is in the wall of the immersion cell.)

The first step in our investigation was to duplicate in the laboratory, if possible, the same types of breakage found in the field. Packed cartons were dropped on to the concrete floor from various heights, such as 10 feet or so, and in other tests the cases were thrown violently against concrete pillars. However, while there was occasionally some breakage found in the cartons so abused, in no test was the characteristic field type of breakage produced. After working on the problem for several weeks, it occurred to Mr. Blessing of this Company that the breakage might happen during handling and shipping when filled cartons were tossed on to other similar cartons. He, therefore, tested this theory with the first success in duplicating field breakage. It was next found that propping up the carton on one side with an inch pipe would tremendously increase the breakage (Figure 1). In fact, if the upper carton was dropped on it from a height of only one or two feet, breakage often occurred. Later it was found that dropping two cartons together would produce breakage very easily.

Visits to the warehouses showed that such events often occurred in the shipping and stacking of the cartons. The four-wheeled hand trucks used for haulage in the warehouses had cleats on their sides which propped up the cartons in the same manner as described above; the chance of dropping two cartons simultaneously was always present. In the unloading of the motor trucks it was quite possible that a carton could fall ten feet or more onto another carton.

It was soon determined that striking the top of a jar while it was held in the hand would also produce this type of breakage. It was, therefore, thought that the contents were hammering the bottom of the jar and causing breakage in much the same way as dropping mercury in an evacuated tube. High speed motion pictures later confirmed this idea.

In July, 1940, the Hartford-Empire Company sent out a bulletin to its Licensees entitled, "Hydrodynamic Breakage in Glass Containers"[1] describing this type of breakage. Consequently from time to time we heard that food packers of Baby Food, Grape Juice, and Catsup, had received complaints of breakage apparently of this type. The full extent of the difficulty cannot easily be determined because actual breakage figures, and the cost due to breakage, are not usually available, but there is no question as to the degree of annoyance.

We are led to believe that water hammer breakage is much more prevalent than is generally imagined, because many such breaks look somewhat like ordinary pressure breaks while others resemble impact breaks.

Description of Water Hammer

When it was discovered that a filled jar could be broken by a blow on the cap, high speed moving pictures were taken of the phenomenon. The successive relevant single frames at 1200 per second are shown in Figures 2, 3 and 4. The pictures show clearly that the blow starts the jar downward, while the contents remain sta-

Fig. 5. High speed flash (2 microseconds) photograph of the bubbles formed at the bottom of the jar.

Fig. 6. High speed flash (2 microseconds) photograph of bubbles found throughout the liquid.

Fig. 7. High speed flash (2 microseconds) photograph of two bubbles in the liquid, four on the bottom.

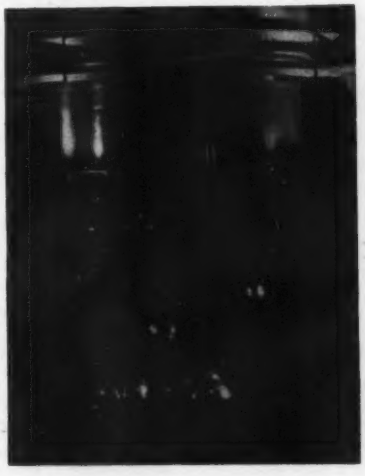


Fig. 8. High speed flash (2 microseconds) photograph of large bubbles forming on sides and bottom.

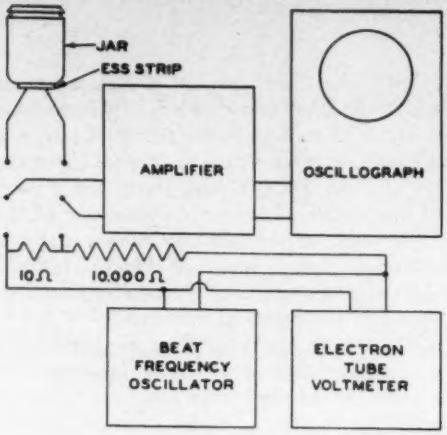


Fig. 9. Diagram of set-up to measure water hammer pressures, with an "Ess" (electrically strain sensitive) strip and a cathode ray oscillograph.

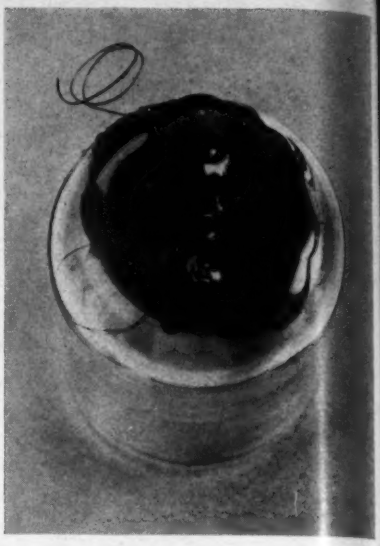


Fig. 10. An Ess strip cemented to the bottom of a jar.

tionary. In a few thousandths of a second the contents move downward and strike the bottom, causing water hammer. At the time of the impact the bottle breaks.

Examining the pictures, it is to be noted that the water does not break out in the form of a slug, but more in the form of a series of bubbles. In Figure 4 monochlorbenzine was used, both inside and outside of the jars to prevent refraction of the light as it passed through the bottle.

Some single ultra rapid flash pictures were taken by the process developed by Professor Edgerton of M. I. T., in which an electric condenser was discharged through a gas-filled tube in two or three microseconds. The lamp was triggered by contacts below the jar so that the jar moved down appreciably before the flash took place. Some of these photographs were taken with the jar immersed in water to reduce the highlights on the outer surface.

The photographs show that at least three distinctly different sets of phenomena can take place. These phenomena are:

1. A cluster of bubbles forming at the bottom of the jar (Figure 5). 2. Fine bubbles dispersed throughout the jar (Figures 6 and 7). 3. A few large bubbles, some of which are not on the bottom (Figure 8).

These three effects can all be produced under the same conditions of impact to the jar, It would appear, therefore, that the internal physical state of the contents, such as fine bubbles acting as nuclei, causes these differences.

If the nuclei are clinging to the bottom, the bubbles start there. If the bottom is free from nuclei, the cavitation starts at some higher place, either on the side wall or in the liquid.

The Study of the Pressures Developed at the Time of Water Hammer

In order to get an idea of the time-strain relationships in a bottle, occurring at the time of water hammer, a carbon resistor, often referred to as an Ess (electrically strain sensitive) strip, was used to convert the variations in extension of the glass into electrical currents. These currents were then amplified and viewed on a cathode-ray oscillograph. The method is described in detail in a paper by A. V. de Forest.[2] A diagram of the experimental set-up is shown in Figure 9. Figure 10 shows a jar to which an Ess strip has been attached.

A typical oscillogram is shown in Figure 11. It was very easy to see the trace in a darkened room, and most measurements could be successfully made without resort to photography. The diagram in Figure 13 shows a typical trace of the water hammer phenomenon viewed on the cathode-ray screen.

The trace starts at A when the single sweep circuit fires. In the first region, from A to C, the water has separated from the bottom of the jar. The vibrations in this region are caused by the initial impact and are the same when an empty jar is struck. Since the pressure on the inside of the base changes from the headspace pressure to vacuum, the average ordinate in the region of B is a direct measure of the headspace pressure. The time from A to C depends on the headspace pressure, the magnitude of the blow, the mass of the contents, and the shape of the jar. Usually this is 5 to 8 thousandths of a second when the headspace is under a vacuum of about 20 inches of mercury, and 3 to 4 thousandths when the headspace is at atmospheric pressure.

In the region from C to G the contents strike the bottom of the jar. The actual physical phenomenon is really quite complicated, because in some places the water strikes before it does in other places, and the bubbles do not all collapse at the same instant. At E the pressure on the bottom of the jar reaches a maximum. The time from D to F is about 1/10,000 sec. in a baby food jar and it may be as long as 8/10,000 sec. in a milk bottle.

The contraction of the jar throws the contents off the bottom at the region around H. This may happen again at I. The rest of the trace is a series of damped vibrations mostly governed by the length of the water column, constituted by the contents of the jar.

Tests on various jars and bottles showed the time of the water-hammer (i.e., from D to F in Figure 13) was constant for any particular bottle and height of fill. The intensity of the water hammer, (i.e. the ordinate at E), was found to vary by as much as 50 per cent under nearly identical conditions of impact. It was only possible to explain this variation on the grounds that essentially different phenomena were occurring from impact to impact. The differences probably arise from the fact that in some cases the bubbles are distributed throughout the liquid, whereas sometimes they all form on the bottom. Occasionally it was noticed that two water hammers occurred only about 1/10,000 to 5/10,000 second apart as in Figure 12. Such a phenomenon might be explained on the basis of Figures 7 and 8, in which

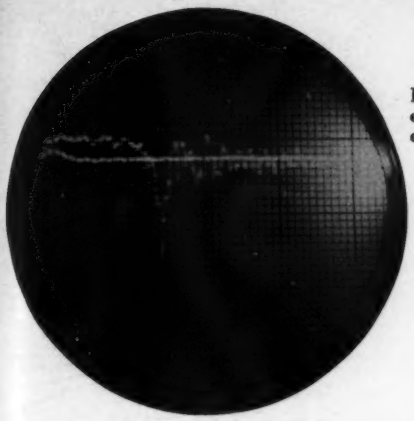


Fig. 11. Photograph of an oscillograph trace at the time of water hammer.

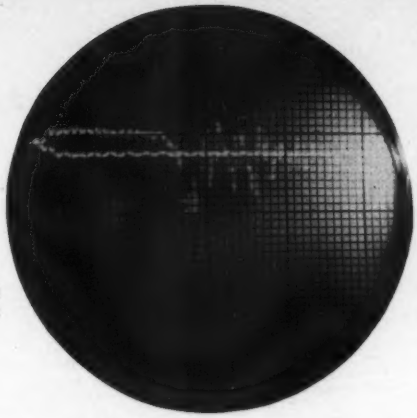


Fig. 12. Photograph of an oscillograph trace of double water hammer.

a set of bubbles is seen throughout the liquid, as well as another set on the bottom. One set of bubbles can collapse in advance of the other set.

Probably the most important observation was concerned with the magnitude of the pressure developed. It was noticed that the pressures were generally rather moderate, even for rather strong impacts. Occasionally a pressure as high as 250 lbs./sq.in. was developed before the bottles broke. Often bottles broke when the pressure was not much over 35 lbs./sq.in. on the bottom of the container. When tests were conducted by dropping a carton on top of another containing a jar with an Ess strip cemented to its sidewall, very strong impacts on the top of the jar were required to produce water hammer pressures as high as 75 lbs./sq.in. Under these conditions it was hard to understand why breakage was taking place at very much more moderate impacts.

Several tests were made with foods and various mixtures inside the jars. In general, all solid particles seem to reduce the pressure of the first water hammer; but, as the contents are stirred by successive water hammers, the pressure is increased—often by as much as a factor of three or four—approaching the pressures developed by a pure liquid.

The pressure developed in a jar when the water hammer pressure was a maximum at E can be estimated by several independent methods. Since the ordinate at B is a measure of the headspace pressure, the water hammer pressure at E is obviously the ordinate at E divided by the ordinate at B times the headspace pressure.

Another method of calibrating the oscillograph was to put air pressure in the jar and suddenly release it. The maximum deflection on the oscillograph would be a measure of pressure released. A third static method that was also used was to put a known pressure in a jar and measure the change of voltage across the Ess strip while a current was flowing through it. A Leeds and Northrup Type K potentiometer had sufficient sensitivity to make a rough measurement.

To get an idea of the strains involved from which the stresses and pressures could be computed, an Ess strip that had been dynamically calibrated by the Hamilton Standard Propeller Company was used in the fourth method instead of the usual carbon resistors. Since the change in resistance produced by a given extension was known from the calibration, the corresponding deflection on the oscillograph screen could be computed when the constants of the amplifiers had been measured. By this method several measurements on the strains produced by water hammer were made.

All these methods of estimating the maximum pressure developed during water hammer agree to about ten or twenty per cent. Careful tests were made on the amplifiers so that no errors could creep in due to a poor frequency characteristic. After a certain amount of redesign of the pre-amplifier, the frequency characteristic was made quite flat from 50 to 10,000 cycles per second.

The General Pressure Effect

By combining the information obtained from the moving pictures, the speed flash photographs, and the oscillograph, we arrived at a very simple explanation of water hammer phenomena. When a container filled with a liquid is struck on the top, the jar starts travelling downward. The liquid breaks away from the bottom of the jar and compresses the gas in the headspace. The pressure of the gas accelerates the liquid and decelerates the jar. Finally the contents catch up with the jar and strike it with an impact. This impact is the water hammer which lasts about 1/10,000 of a second as shown by the oscillograph. A pressure is developed which is at a maximum at the bottom of the jar and tapers off to the headspace pressure at the top of the contents. Rough estimates with the oscillograph indicate that the decrease of pressure from the bottom to the top is approximately linear. Since pressures as great as 250 lbs./sq.in. can be developed on the bottom of the jar by this general tapered pressure, bottles can be broken by this effect alone, and a fracture pattern very similar to a hydrostatic break will be produced.

(To be continued in the November issue)

[1]The term "Water-Hammer Breakage" was adopted after investigation revealed the mechanism of the process.
[2]A. V. de Forest, "Measurement of Propeller Stresses in Flight," Journal of Aeronautical Sciences, [4] 4 227 (1937).

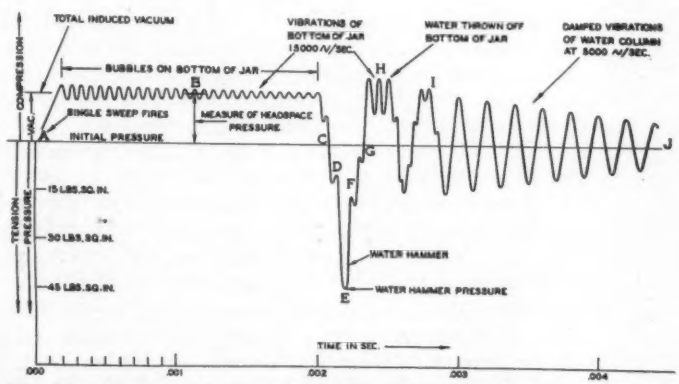


Fig. 13. Drawing of a typical oscillograph trace of water hammer in a small jar with atmospheric pressure in the headspace.

G. C. A. HOLDS FALL MEETING AT SEIGNIORY CLUB

The Glass Container Association's autumn meeting was held this year during three days of perfect weather (Sept. 22-24) at Canada's Seigniory Club. The beauty of the location, in the Laurentian hills facing the placid Ottawa River, and the cordiality of T. W. Bassett and I. J. Macdonald of the Dominion Glass Company, who acted as hosts, went far toward making industry members forget the intricate problems now facing them. Between meetings which tackled the maze of priorities, the demands of defense work or the complexities of peak volume, members found relief in the less strenuous problems presented by the lie of a golf ball on a tricky course or the instincts of a speckled trout. The meeting was unusually well-attended, registering approximately a hundred and twenty-five members and some thirty of their ladies.

Striking the keynote of war-time seriousness which dominated all the sessions of the meeting, the address of the Hon. J. T. Thorson, Canada's Minister of National War Services, welcomed the industry on the first morning. Mr. Thorson, an Icelander by ancestry with a long, distinguished career of public service behind him, described the military and financial efforts which the present war is exacting in Canada, and listed the new bonds which are binding North America's two greatest nations together.

The principal accomplishment of the meeting was the move to obtain accurate knowledge of the industry's requirements of materials for full operation. In the face of mounting packaging demands, requiring expanded volume particularly of glass, data of this kind will be essential. Already, as V. L. Hall, assistant business manager, pointed out, the Association's statistics have proved of real value to various agencies in Washington. The new set-up of SPAB, under which requirements both for defense and essential civilian needs will be figured, will make statistics on requirements by the glass container and closure industries of immediate and vital importance. This is especially true in view of the relatively small amounts of the critical materials, with the exception of paper, which are essential to glass packaging. The meeting took active measures to present such data to the proper authorities in Washington.

In an address outlining the role of the Association in the emergency, Mr. Hall described the new functions created by the Defense Program as well as the activities of the older departments such as those devoted to traffic, standard testing procedure and glass research.

"At the present time, operating with ample volume," said Mr. Hall, "we have a new set of problems, chief of which is the uncertainty of obtaining all the materials, supplies, equipment and transportation necessary to produce and move this expanded volume. Up to date, these problems have not been great. In order to appreciate that the situation will become increasingly difficult, one need only review the Defense Program plans and figures.

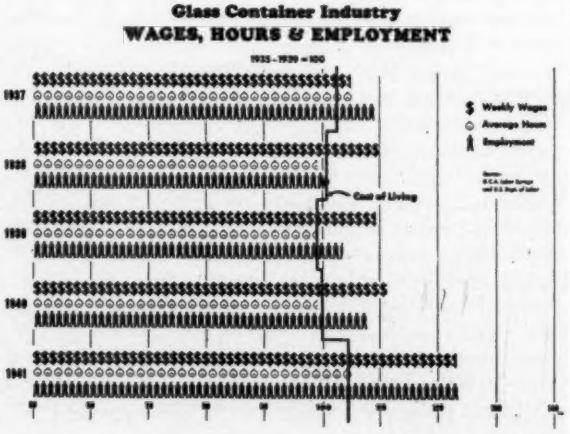
"The total defense program is now 60 billion, including our country's program, the lend-lease program and foreign orders. Of this total, contract awards have been made for approximately 30 billion, or one-half. At the end of August the total defense expenditures amounted to about 11½ billion, or roughly one-fifth of the over-all program as it now stands. However, a good part of these expenditures is represented by plant expansion and tooling up, which means a greatly accelerated rate of expenditure as these plants start to produce. The present rate of expenditures, running slightly over one billion a month, is expected to reach 1.4 billion by the end of the year, and probably 2 billion by next June.

"These figures illustrate, I believe, better than any other means, the increasing demands which the defense program will make on all the critical materials, the facilities to produce and the nation's man power. Our closure industry has virtually eliminated the use of aluminum, and difficulty has been experienced in obtaining the increased quantities of plastic compounds, zinc, and liner materials such as cork, vinylite and paper. In the glass container field, machinery and equipment, metals for repairs and maintenance and shipping cartons, are a few of the items giving real concern.

"Keeping informed of the developments and regulations sponsored by the various defense agencies is in itself a major problem. The Association will act as a clearing house to the industry for much of this data. Copies of releases and orders from the SPAB, OPM and OPA are now being received, and a summary of those affecting the industry will be sent to you."

A statistical picture of the industry and its position among other industries, presented by the Association's secretary-treasurer, H. W. Kuni, revealed the startling effect of the present emergency on glass container production and shipments. June, with total shipments of 6,865,000 gross, set a new high mark for the industry, the August total trailing slightly with 6,801,000 gross. The total for the first eight months this year, 45,600,000 gross, already exceeds the entire 1938 volume by 4.8 per cent. Unusual too is the fact that the index of glass container production, which up to the first of this year closely followed the index of non-durable goods production, has since then been pushed up sharply out of line, due largely to threatened shortages of competitive packaging materials.

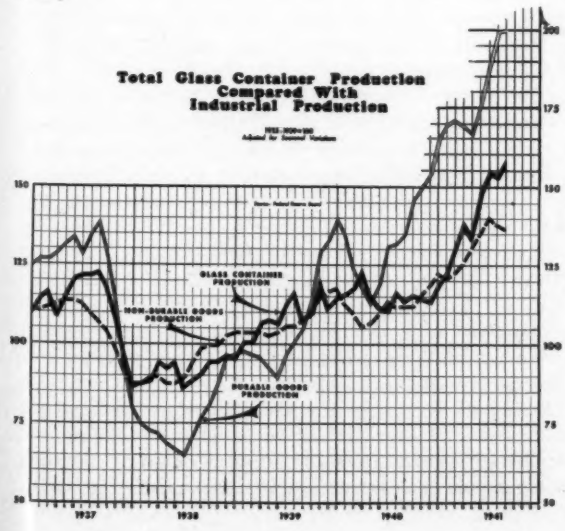
The direct co-operation of the industry with the Defense Program in the production of war supplies was reported by C. P. Overmyer, who was appointed co-ordinator of this type of activity at the spring meeting of the

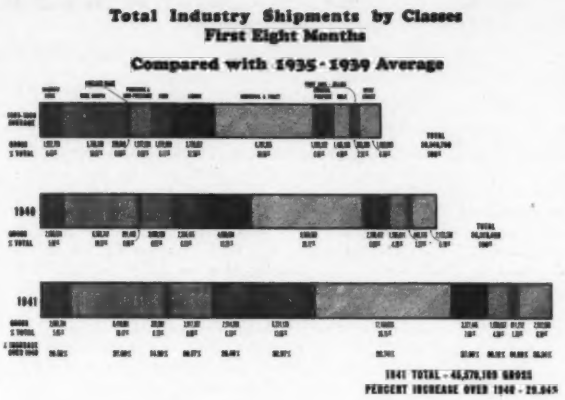


Association. The larger companies of course, have already diverted as much as possible of their machine and mold shop facilities to defense production, and are turning out substantial quantities of machine parts on a subcontracting basis. The problem has been to bring the smaller companies into the picture. Here the job undertaken by Mr. Overmyer has been successful in working out a pattern of organization, exploring the types of contracts best suited to mold shop machinery, and in proving the high quality of work which could be turned out for these types. In June, a group of glass container manufacturers in Indiana and the nearby territory undertook a sub-contract for parts for 50 shell-loading machines. This order, totalling between $80,000 and $90,000, has been completed, and there is more work in sight from the same source.

"The Indiana experiment has set a pattern that we can follow in other sections of the country where our plants are conveniently grouped together," Mr. Overmyer said. "In this connection a good way to operate is to elect a prime contractor from the group who would head up the work so that each of the cooperating subcontractors gets uniform instruction and information. This is a little bit of organization that enables things to move smoothly and will probably save grief later on. Because of the fine job that our manufacturers did in turning out quality work according to schedule, the prime contractor was contented to pay a premium to our group. I feel we have good reason to be proud of this job which was in the nature of a first trial.

"I have tried to spread the word of our industry program in contacts with OPM at Washington, the various regional OPM offices, Ordnance Divisions and prime contractors. Everyone has had a good word to say about the program and wants to cooperate with us to the fullest extent. We have had difficulty in finding the right kind of work for our shops, but as more work is let pressure on all machine tool facilities throughout the country will be felt. I have the feeling that presently almost every shop capable of producing defense material of one kind or another will be required to do so. Our efforts so far have given us valuable experience and a pattern upon which to operate intelligently and efficiently"





Research and promotional activities, curtailed at the spring meeting, were further cut drastically to a minimum. The budget now allows only for a limited amount of market research and the publication of a few issues of the two house organs, now six years old, *The Beer Bottler* and *The Bottle Front*. This means the immediate discontinuance of the Glass Kitchen. Retrenchment in the trade promotion program, due partly to the government suit and partly to current developments in a war-time economy, will, however, leave opportunity to carry on the collection of basic market data which apply to the whole industry and which should be of service to the whole industry when the present emergency is over. F. P. Gass, reporting on promotional activities since the spring meeting, pointed out that shortage of pulp may not affect paper milk container production, since less than one-tenth of one per cent of the normal pulp supply is devoted to that purpose. Other factors are, however, tending to reduce distribution of paper containers in some of their oldest strongholds. Beer bottle sales have been even more benefited by current shortages and market shifts than have milk bottle sales. The larger market for glass beer containers is due both to larger packaged volume and to displacement of the volume formerly sold in cans. In the food field, the promotional department has spent most of its effort in smoothing the path to success of the Army Jar, the industry's outstanding recent example of a unit-capacity container.

J. S. Algeo made an interesting announcement for the Designs and Specifications Committee concerning a forthcoming line of simplified food containers, designed with an eye to economy of both container and closure. This is an example of the industry's campaign for standardizing containers, which coincides with a policy already broadly outlined by SPAB and mentioned in earlier sessions by Mr. Hall.

Over a sporty golf course, consisting of a series of narrow fairways completely surrounded by hazards, glass men and suppliers devoted one afternoon to tournament play. Winner of low gross was A. E. Jones of the Irvington Varnish Company with an 83. Low net for one flight of experts was H. E. Hattersley of Solvay Sales Company with a 70, and low net winner of a second flight of lesser experts was T. W. Bassett of Dominion Glass with a 71. R. A. Blunt of the Buck Glass Company and R. A. Horning of Armstrong tied to win the kicker's handicap.

WATER-GLASS

By DR. BRUNO SCHWEIG
Reading, England

Editor's Note: This paper is abridged somewhat from Dr. Schweig's manuscript. Space does not permit the inclusion of much of his historical material, which traces the development of silicates of soda from their first appearance, about the 16th Century, to the present state of the industry. The author quotes J. G. Vail, author of "Soluble Silicates in Industry," as placing the number of articles and papers on water glass in excess of 6,000. War-time conditions bringing deficiency of fats are mentioned as having always increased the demand for soluble silicates as detergents, and their use in fire-proofing, in stone hardening, and particularly as adhesives has brought the industry to a point where the U.S. alone produces more than 600,000 tons per year of liquid water glass, at a cost of about $11.00 per ton.

The name of water-glass with its two components is easily explained. Ordinary glass can be defined in a condensed and simplified way, as a double or multiple silicate; with the specification that one of its metal bases must be an alkali metal (or several of them), whereas the other metal or metals belong to the earth-alkali group, sometimes also to another. All glasses of this type are insoluble in water. By contrast, water-glass contains only a metal of the alkali group (or several of them), its simplest form being therefore Na_2SiO_3, which is the same as $Na_2O.SiO_2$. These alkali-silicates are soluble in water. The similarity in composition and manufacture as well as original appearance accounts for the name "glass," while its solubility in water and the fact that it is nearly exclusively made use of in its liquid form induced J. N. von Fuchs to call it "water"-glass. The name applies equally to the solid form and to the aqueous solution.

The formula $Na_2O.SiO_2$ represents, however, only one special case of water-glass. The general formula is $Me_2O.nSiO_2$, "Me" standing for one or several alkali metals and "n" indicating the molecular ratio of the silicic acid to the alkali. One was tempted to assume that "n" must be a whole number, as silicates of the formulas $Na_2SiO_3.Na_2Si_2O_5$, $Na_2Si_3O_7$, $Na_2Si_4O_9$, etc., are known. However, it was found that the properties of the alkali-silicate-fusions change constantly and evenly with the composition, thereby indicating no special chemical individuality. Besides, one does not know with certainty how much of real silicates, of free silicic acid, and perhaps also of free alkali, is contained in the molten compounds at different temperatures. Therefore, the molecular ratio "n" may be, and mostly is, a fraction, varying, for instance, for sodium-water-glass from 1.2 to 4 corresponding to the formulas $Na_2O.1.2SiO_2$ to $Na_2O.4SiO_2$.

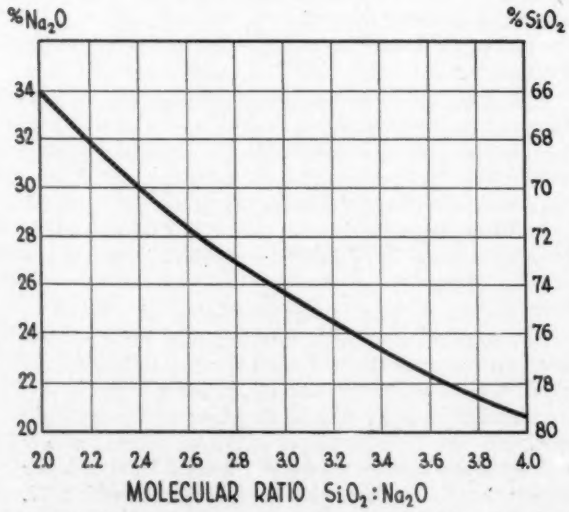


Fig. 1. Composition and molecular ratio of solid water-glass.

The connection between the molecular ratio of silicic acid to alkali and the composition of pure sodium water-glasses, though easily calculated, may be seen from Fig. 1.

If the molecular ratio is known, one looks at the corresponding point of the curve and finds on the left and on the right the percentage by weight of Na_2O and SiO_2 respectively, adding up to 100. Vice versa, if one intends to find the molecular ratio from the composition known, for instance, by the analysis, one takes the corresponding horizontal to the point of intersection with the curve and finds the molecular ratio from the bottom line.

TABLE 1

Trade brands of SOLID water-glass

No.	Name	Color	Mol. Ratio	Composition SiO_2 %	Composition Na_2O %	Impurities %
1.	Neutral Sulphate-glass	Blue green	3.2-3.5	75	23	Up to 2
2.	Neutral Soda-glass	Light yellow	3.2-3.5	76	23	Up to 1
3.	Alkaline glass	Brown	2.0-2.2	66	32	Up to 2
4.	Potash Water-glass	Light brown	3.5-3.8	70	K_2O 29	Up to 1

Attention has to be paid to the fact that the molecular weights of silicic acid 60.06 and of sodium oxide 62.00 are close together, and that, therefore, the molecular ratio differs only by 3.1 per cent from the weight ratio of the two. Some mistakes may otherwise arise from this coincidence.

For practical considerations, manufacturers and consumers have agreed to confine themselves to a few commercial brands and not to produce or sell water-glass of all possible ratios. Sometimes one speaks of Sulphate or Soda water-glass, according to the raw materials. But these water-glasses, when properly fused, are identical.

The color of the solid water-glass varies to a great extent. The glasses can be green, yellow, or not tinted at all. In Table 1, some properties are given. But all of them, including the colors, are only indications of the properties of the average products. For instance, it is commercial practice to choose a higher silica ratio for the water-glass on sale in summer than for that in winter in order to keep the viscosity as stable as possible. The impurities, mostly from the furnace or from the fuel, may amount to 2 per cent, and comprise Fe_2O_3, Al_2O_3, CaO, MgO and sand or fire clay.

TABLE 2.

Trade Brands of LIQUID Water-glass

No.	Name	Mol. Ratio	Composition SiO_2 %	Composition Na_2O %	Composition H_2O %	Solid glass in solution %	Density	Viscosity at 20°C. Water = 1
1.	Sodium Water-glass 36/38° Be.	3.3	26.5	7.9	65.6	34.4	1.34	20-200
2.	SWG 40/42°	3.3	29.0	8.9	62.1	37.9	1.40	40-400
3.	SWG 50°	2.6	35.0	13.5	51.5	48.5	1.53	200-2,000
4.	SWG 60°	2.1	37.0	18.0	45.0	55.0	1.71	1,000-10,000
5.	SWG 70°	1.6	37.0	23.0	40.0	60.0	1.92	8,000-80,000
6.	Potassium Water-glass 31°	3.6	21.0	K_2O 8.6	70.4	29.6	1.27	10-200
7.	Water-glass crystalized	1.0	21.0	21.0	58.0	42.0	1.55	*200-500* *when molton

Liquid water-glasses are also mostly sold in certain grades of strength. Variations can be easily obtained by mixing different brands. Table 2 shows the varieties of water-glass mostly used in the trade. The brand No. 1 of Table 2 is the most important, and constitutes more than 90 per cent of all the water-glasses in use, and is also the one sold in retail shops.

The liquid water-glass is classified, as a rule, according to its density, measured in degrees Baumé, and to its molecular ratio of silicic acid to alkali. Density (d = sp. gr.) and degrees Baumé are related according to the following equations:

$$\text{Degree Baumé} = 145 - \frac{145}{d} \quad \text{and vice versa:}$$

$$d = \frac{145}{145 - \text{degree Baumé}}$$

The impurities of the technical water-glasses, both solid and liquid, are very small. Sometimes there occurs some sodium sulphide or potassium sulphide, imparting a nasty smell to the solutions. The sulphur most probably comes from the heating gases and can be either avoided by melting well in an oxidizing flame, or removed from the solutions by adding hydrogen peroxide or precipitating it with a suitable metal salt.

Analysis

Water-glass, consisting, if pure, of only two constituents, can rightly be expected to offer no special difficulties to the analyst. The main, and often sole, object of its analysis is to establish the ratio of SiO_2 to Na_2O or K_2O, as the case may be. Sometimes the impurities have to be determined. They usually consist, as we saw, of F_2O_3,Al_2O_3, CaO, MgO, and some residue, insoluble in hydrochloric acid, totalling about 2 per cent. It is not necessary to enlarge here on their determination, as it is done by ordinary analytical methods. The impurities present in the solid water-glass hardly ever occur in the solution of water-glass, being retained by the filter or as precipitate at the bottom. This fact simplifies still further the analysis of the solution.

The solid water-glass has, of course, to be dissolved before it can be analyzed. Sometimes, especially with very basic silicate, the water-glass, after being crushed to a very fine powder, dissolves in hot water and can immediately be titrated after dilution. More often it is readily decomposed by hydrochloric acid, forming silicic acid and sodium or potassium chloride. Usually, however, the solid water-glasses have to be made easily soluble by fusing together 1 part of water-glass and 4 to 8 parts of sodium carbonate in a platinum crucible. The mixture is then dissolved in hot dilute hydrochloric acid.

The gravimetric determination of the silicic acid present in water-glass is always done in the same somewhat complicated and lengthy way, whether starting from an original solution of water-glass or from the solution of the fused mixture in diluted hydrochloric acid. The principle is: (1) to precipitate the silicic acid with hydrochloric acid according to the basic equation $Na_2SiO_3 + 2HCl = SiO_2 + 2NaCl + H_2O$, (2) to dehydrate the silica and make it insoluble by gentle heating, and to wash off the soluble chlorides, (3) to complete the dehydration and to convert the precipitate into anhydrous silica dioxide by igniting at a very high temperature, (4) to weigh it in this form. Sometimes another (5) operation is added, especially when it is feared that an unusually high proportion of impurities are precipitated together with the silicic acid. In this case the silica is then treated with hydrofluoric and sulphuric acid to volatilize it as silicon tetrafluoride:

$$SiO_2 + 4HF = SiF_4 + 2H_2O.$$

The excess of acid is evaporated and the residue ignited to the oxide. The loss in weight of the precipitate represents pure silica.

For the dehydration, often hot concentrated sulphuric acid and also perchloric acid are used as very effective agents. Especially, a dehydration with perchloric acid can be completed much more quickly than an evaporation to dryness. Furthermore, the perchlorates are all soluble.

The determination of the alkali is comparatively simple. With solid water-glasses the silicic acid is volatilized

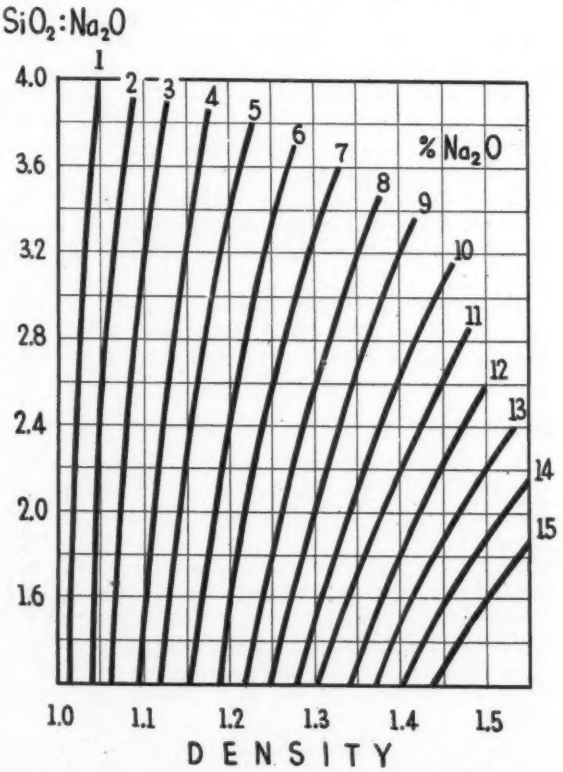


Fig. 2. Curves of equal Na_2O content in relation to mol-ratio and density for quick analysis of fluid water-glass.

by treatment with hydrofluoric acid as described before and the basic metals of the residue analyzed. For the purpose of a quick analysis of the alkali in solid water-glass the following procedure can be taken: The water-glass is well pulverized and treated in a platinum crucible with hydrofluoric and sulfuric acid. The residue, when ignited, consists almost solely of sulfate. If the sulfates amount to "r" per cent of the solid water-glass, then the molecular ratio "n" of pure sodium water-glass is: $n = 236.5 \div r\text{-}1.031$.

With liquid water-glass, the determination of the alkali is still easier, because of the hydrolysis of the alkali silicates. As silicic acid is such a weak acid that it does not affect methyl-orange, titration with normal acids, for instance, with $\frac{N}{5}$ hydrochloric acid, is possible. It is however, necessary to dilute before adding the acid, to prevent the precipitation of silicic acid, as the precipitate may retain some alkali. Phenolphtalein cannot be used, because it produces unreliable results. Potassium can be separated from sodium by precipitating it as perchlorate after the volatilization of the silica with hydrofluoric acid.

Gravimetric method of direct sodium determination in the presence of potassium: Comparatively recently, in the last twelve years, the method of precipitating sodium with zinc-uranyl acetate has been developed. A good description of the procedure was given by Messrs. P. A. Webster and A. K. Lyle in a paper on "Short Methods of Chemical Analysis of Glass." *Jour. Amer. Ceram. Soc.*, 1940, p. 235. The procedure for the dehydration with perchloric acid is included.

A quick, rough test for technical purposes: The composition of water-glass solution is often calculated from its density. This, in combination with the easily determined amount of alkali, is a means of finding the molecular ratio and, consequently, the content of silica.

Instead of calculating the molecular ratio from density and alkali content, curves like those in Fig. 2 may be used.

One finds where the curve with the analyzed Na_2O content intersects the vertical line indicating the density. The horizontal line through this point shows the molecular ratio SiO_2:Na_2O.

The relation of density (specific gravity) to molecular and weight ratios, and to the percentage of solid in a solution of sodium water-glass can be seen from Table No. 3.

TABLE 3

Composition of Some Commercial Grades of Sodium Water-Glass.

Spec. gravity	Molecular ratio $\frac{SiO_2}{Na_2O}$	Weight ratio $\frac{SiO_2}{Na_2O}$	Per cent solid in solution
1.235	4.2	4.06	26.8
1.325	3.8	3.68	33.4
1.375	3.0	2.92	35.5
1.39	3.3	3.21	38.4
1.42	2.9	2.82	44.5
1.56	2.5	2.38	46.7
1.6	2.0	1.95	48.7
1.7	2.0	1.95	54.5

Properties

The physical and chemical properties of the solid water-glasses follows closely those of the glasses with low content of earth-alkali metals. Well melted water-glasses look very similar to greenish or yellow bottle glass. They have the same density, the same lustre, break in the same mussel-shaped way, show the same light refraction, similar hardness, brittleness and elasticity, equal sensibility for rapid change of temperature, slow softening with increase of temperature instead of sudden melting, in short, they behave like genuine glasses.

The viscosity of molten water-glass is very important and characteristic. It increases quickly with the augmentation of the silica content. Water-glass of 70 per cent SiO_2 is, at all temperatures, about four times as viscous as that of 60 per cent SiO_2. Potassium water-glass is much more viscous than sodium water-glass of the same molecular ratio.

The one fundamental difference between water-glass and ordinary glasses, is, as we have seen before, its solubility in water. It is possible to make solutions containing 30-60 per cent of the solid glass. Therefore, water-glass is highly soluble, but it is not easily soluble if, by that, quick solubility is understood. On the contrary, water-glass dissolves only very slowly. So slowly, indeed, that lumps of water-glass, even if in contact with water for several days, hardly lose any of their weight. Therefore, solid water-glass in big lumps can be transported in open wagons. It is also not possible to taste water-glass, whether in small lumps or freshly pulverized, though even very diluted water-glass solutions show a distinctly alkaline taste. It takes hours to disolve only a few per cent of finely pulverized water-glass, regardless of whether cold or warm water is used. At 100° C. the solution succeeds only under special conditions. At 140° to 160° C., however, temperatures which, of course, can only be obtained under pressure in an autoclave, even big lumps are completely dissolved in a relatively short time. It seems that the process of solution is different from that of other materials; it is possibly of a physical-chemical kind whose nature is not yet completely known.

The solubility is greatly impeded if earthy impurities be present, so that sands containing mica, feldspar, lime, clay, iron oxides, etc., are not suited for making water-glasses. When a water-glass containing these impurities is treated with boiling water, earths and metal oxide may be left as an insoluble sediment. Some foreign matters may be dissolved because the solution of water-glass can dissolve traces of most oxides, and the solvent power increases with the concentration of the solution. Hence, a solution which is slightly turbid when diluted becomes clear by concentration and conversely. Even the oxides of calcium, barium, and magnesium are slightly soluble in water-glass liquor.

When a few drops of diluted solution of a metallic salt are added to water-glass, the precipitate first formed will generally disappear, when the mixture is agitated. Consequently, *liquor silicium* may dissolve appreciable amounts of oxides of iron, zinc, manganese, tin, lead, copper, and mercury.

The rate of dissolving of solid water-glass is greater when a small amount of water is used than when using larger quantities. This surprising observation finds its explanation in the fact that a thin film of silicic acid is formed on the surface of water-glass, if it is attacked by water or an acid liquid. The silica film protects the

water-glass from further attacks, but easily dissolves in alkali, or in a solution of water-glass which is itself alkaline. That is the reason why it is preferable to dissolve solid water-glass in weak solutions of water-glass.

The liquid water-glasses are of a colloidal nature, characterized by their inability to crystallize, their high viscosity, and the ability of forming gelatinous precipitates. It is, however, possible to obtain crystallized alkali silicate from strongly alkaline solutions. Usually meta-silicate, $Na_2SiO_3.9H_2O$, melting point 47° C. crystallizes in rhombic particles. Sometimes meta-silicates with less water, $Na_2SiO_3.6H_2O$ monoclinic, melting point 62° C., and $Na_2SiO_3.4H_2O$, hexagonal, melting at 85° C. are formed. These meta-silicates with the molecular ration $n = 1$ are not genuine water-glasses, as their nature is different from that of a non-crystallizable glass. Water-free meta-silicate melts at 1089° C. It crystallizes so easily that it cannot be obtained as a glass in lots larger than one ounce.

Evaporation of water-glass without stirring leads to the formation of a transparent film on the surface and on the walls of the vessel. This hinders the conduction of heat and must be prevented by strong agitation. Water-glass, if carefully evaporated, avoiding vapor bubbles, by heating for instance on the water bath, leaves a hard, glassy mass. It is always soluble in hot water or in alkali, or sodium carbonate, lye, provided that it is not decomposed by the carbon dioxide of the air. Layers of water-glass, even if apparently dry and impervious, are still capable of absorbing water and exuding it somewhere else. It is, therefore, not an absolute protection against drying up like an oil or wax film, but only prolongs the drying process.

Strong boiling of water-glass solutions with the formation of steam bubbles soon leads to ebullition and boiling over and eventually produces large quantities of fine, snow-white foam which becomes solid on cooling.

Solutions of water-glass, if exposed to the cold, do not change substantially. The viscosity increases considerably; at —3° to —5° C. the solutions become turbid through the formation of ice crystals or flakes, but on warming the original state is re-established.

If water-glass is preserved in glass bottles, the viscosity very often increases. That has nothing to do with ageing, as the viscosity remains constant when water-glass is kept in iron vessels. Probably some of the glass from the bottles has entered the solution and caused the increase in viscosity.

The boiling point of water-glass solutions of 38° Bé. lies at 100.4° C., that of a 60° Bé. "alkaline" solution at 104.7°, and increases to 112° C. in a 58° Bé. solution of Na_2SiO_3. All solutions of water-glass are alkaline. Yet water-glass of the constitution $Na_2O.3.3SiO_2$ is often called "neutral" or "acid," whereas $Na_2O.2SiO_2$ is marked "alkaline."

The chemical reaction of water-glass with acid was partly dealt with above under "Analysis." All strong acids (even CO_2) replace the silicic acid and precipitate it either in a gelatinous form or as an amorphous white residue. Warming and concentration favors the building of the residue and the solidifying. Very weak alkaline solutions, such as produced by a mixture of ammonia and ammonium chloride, seem to be the best for a quick formation of a gelatinous or solid precipitate.

Alcohol, by attracting the water, separates the water-glass from its solution and leaves it in a slimy or granular form when the molecular ratio is 2, or 3 and more, respectively.

Water-glass "Gardens" or "Inorganic Moss"

The salts of the heavy metals, the earth-alkali metals —calcium, strontium, barium, also aluminum and zinc, all react with solutions of water-glass by producing a precipitate of silicic acid, metal hydroxide, water, and mixtures of these. Some reactions will be dealt with later on when speaking of the use of water-glass. Of special interest, particularly to the tyros in the study of osmotic pressure, is the formation of silica "trees and gardens" or "inorganic moss," when small crystals of different salts are thrown into a water-glass solution of about half its normal strength: A liter beaker is filled with a solution of water-glass (sp. gr. 1.1) and crystals of, say, cobalt nitrate, cadmium nitrate, nickel sulfate, copper sulfate, ferrous sulfate, manganese sulfate, zinc sulfate, etc., are dropped into the beaker so as to rest on different parts of the bottom. The whole is allowed to stand in a quiet place, when beautiful plant-like shoots will be seen growing with a form and color characteristic of each metal. The precipitate, built in the beginning round the crystal, operates as a diaphragm, which is inflated by the osmotic pressure and lifted by the adherent air-bubbles and the lower density of the salt solutions. The addition of solutions of potassium bichromate or permanganate or prussiate does not form precipitates but gives color to the liquid. The strangeness and beauty of the "gardens" not only delight the novice in chemistry, but also aroused the astonishment and enthusiasm of the earliest investigators in water-glass, such as Glauber. (*To be continued in the November issue.*)

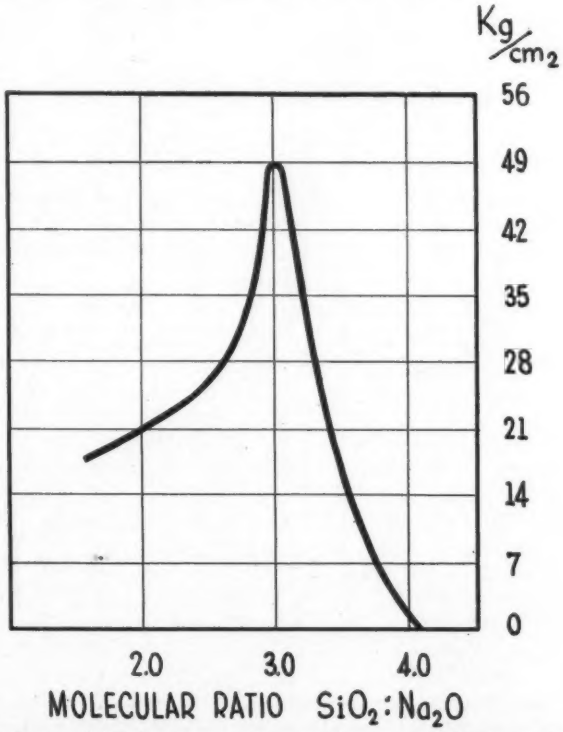


Fig. 3. Adhesive power of water-glass in relation to mol-ratio, measured by the shearing strength of cemented walnut. By McBain and Hopkins.

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During August

Compositions

As a contribution to the art of fining glass by the use of sulfur, selenium and tellurium (the sixth periodic group) Aaron K. Lyle of Hartford, Conn., contributes the information that their respective effectiveness is first tellurium and lastly sulfur. Hesitancy in the use of tellurium and selenium may have been due, as Lyle suggests, to their coloring action which was not suitable for making clear colorless glass. Basis for the invention which he has just covered by patent 2,252,131, assigned to Hartford-Empire Co., is the discovery that the use of arsenic or antimony in conjunction with tellurium and selenium will prevent this discoloration. He illustrates the invention in terms of a soda-lime glass in which 2 lbs. each of arsenous oxide and tellurium are added in a total batch of 1674 lbs.

Special types of glass compositions assigned to General Electric Co. were described in patents 2,252,466 to Walter Hänlein, Berlin-Haselhorst and 2,252,495 to Werner Düsing, Berlin-Tempelhof, Germany. Hänlein's aim was to develop a glass which could be used in place of quartz for electric discharge bulbs such as high-pressure mercury-vapor lamps. He states that ordinary glasses are unsuitable because of their devitrification tendency when heated to 1000° C. The glass compositions which Hänlein finds satisfactory fall within the range shown in Table I.

TABLE I

Hänlein Patent 2,252,466

	Per cent
SiO_2 (Silica)	90 to 94
Al_2O_3 (Alumina)	3.0 to 5.0
ThO_2 (Thoria)	0.5 to 1.0
ZrO_2 (Zirconia)	0.5 to 2.0
CaO (Lime	0.5 to 1.0
BaO (Barium Oxide)	0.5 to 1.0
BeO (Berillia)	0.0 to 0.5

Düsing also proposes substitutes for quartz glass, but is interested primarily in glasses which will equal or aproach the infra-red ray transmitting properties which are exceptionally well developed in quartz glass. His glasses contain 71 to 76 per cent CaO, 12 to 15 per cent SiO_2, and 12 to 15 per cent ZnO or BaO. Düsing cites infra-red transmissive values for his glasses and others.

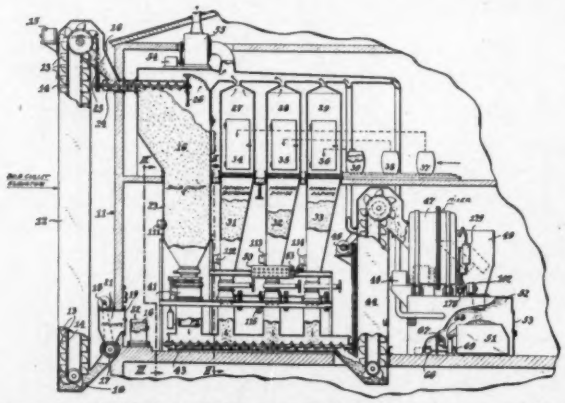


Fig. 1. 2,252,589: Whitmore and Newcombe. Batching machine whose automatic cycle, initiated by an electric switch, includes cullet crushing, automatic weighing of batch ingredients, conveying and elevating to a mixer and discharging to a batch car.

Fluorescent materials are the subject of patents 2,252,500 to Gorton R. Fonda of Schenectady (General Electric Co.), 2,252,552 to C. J. Calbick, of Chatham, N. J. and John C. Cook of Westwood, N. J. (Bell Telephone Laboratories Inc.), and 2,252,590 to Henry Wolfson of London, England (Western Electric Co.).

Figure 1 taken from patent 2,252,589, which James B. Whitmore of Bloomfield and Frank A. Newcombe of Nutley, N. J. have assigned to Westinghouse Electric & Mfg. Co., may be considered to be the last word in automatic batching. The "machine" receives and crushes glass cullet, automatically proportions it with other glass-making materials to produce a predetermined glass formula, mixes the batch and discharges it to a transfer car, and does all of these things automatically upon the mere closing of an electric switch. Constituent units operated by the automatic controls include a dust collector, conveyors, elevators, weighing machinery, mixer, bin discharge devices etc. Safety controls automatically cut off the cullet elevator when the bin is filled. Also if any other part of the system becomes jammed or over-loaded or if the cullet bin runs empty the entire machine stops immediately and cannot be started until the trouble is corrected. Another safety device renders the machine inoperative if there is no empty batch box under the mixer discharge.

Referring to Figure 1, cullet from the largest bin at the left is weighed at 41, fed to a worm conveyor, where it joins other measured batch materials from bins 31, 32, and 33, and is conveyed and elevated to the mixer 47. In the automatic cycle of operations described by the inventors ten weighings of cullet occur for each mixer charge. The other batch materials are not measured out until three weighings of cullet are completed.

Furnaces

In forming sheet glass by the Colburn process (described in patent 1,248,809 of 12-4-1917) John F. Byers of Charleston, W. Va., has developed an electric induction heating system for the working end of the glass tank. The purpose is to improve the control of the working properties at this point. The furnace hearth is made of standard refractories but is encased in refractory conductors such as graphite, which also extend over the top of the drawing section. By means of an inductor coil which is wound around the whole structure, a high frequency induction field is developed which heats the graphite so that it conducts heat to the glass through the refractory walls. This is patent 2,252,756, assigned to Libbey-Owens-Ford Glass Co.

Kenneth B. McAlpine of Pittsburgh describes in patent 2,254,079 (Pittsburgh Plate Glass Co.) a method of freeing glass of bubbles, which requires a modified tank construction. He mentions that the major proportion of such batch gases as carbon dioxide, sulphur dioxide and water vapor, escape from the glass as fairly large bub-

bles but that smaller bubbles are removed only after long fining periods. Larger bubbles which may collect these small ones are sometimes deliberately introduced as in the old practices of supplying potatoes, wood, etc., whose decomposition in the glass released large volumes of gas. The process now proposed by McAlpine is to flow the melted glass as a thin sheet over a hearth section through which such a gas as carbon monoxide is bubbled for sweeping purposes. As illustrated in the continuous tank of Figure 2, whose melting end is at the left, the glass depth is restricted in a center section; carbon monoxide is bubbled into the glass through vents 30. Since the gas may tend to discolor certain glasses, a corrective oxidizing gas may be introduced from ports fed by the distributor 28.

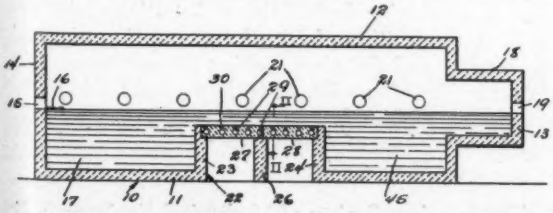


Fig. 2. 2,254,079: McAlpine. Carbon monoxide is bubbled through vents 30 of a continuous melting furnace to sweep tiny residual gas bubbles from the glass.

Feeding, Forming and Shaping

Patent 2,252,195 granted to Everett Niles of Willoughby, Ohio (General Electric Co.) describes an automatic machine for preparing short stems for the bases of incandescent lamps; the operations include fusing the glass stem around the lead-in wire.

Louis Poglein of Jeannette, Pa., in patent 2,252,292 (McKee Glass Co.) discloses a mold design for pressed glass ware, in which the curvature of the plunger and mold allows the plunger to enter the mold with minimized wear. Patent 2,253,497 to Frederick L. G. Kollmorgen of the Kollmorgen Optical Corp., Brooklyn, concerns a method of making dies for molding contact lenses.

To an Owens-Illinois group composed of Joseph P. Benoit, Russell G. Allen, and Luther H. Wideman, all of Alton, Ill., two patents were isued for glass blowing machines. One describes a shearing mechanism (2,252,392) which is mounted separately from the mold carriage but with inter-connecting means which move the shears up and down as adjustments are made in the mold carriage to allow for molds of different heights. The second patent 2,252,391 covers an Owens type suction machine for blowing hollow ware such as bottles and jars, and particularly difficult pieces such as rectangular panel-faced bottles. The parisons or blanks are blown in preliminary molds, then in intermediate molds whose shape aproximates the final form, and are then blown to final form in the finishing molds.

A plan view of this three unit machine is shown in Figure 3. A charge gathered at the fore hearth 85 shown at the extreme left moves to the right through the three rotary forming units of which the third discharges the finished ware on conveyor 242.

Work in the field of foliated glass at the Corning Glass Works has culminated in the issuance of patents 2,251,726 and 2,251,727 to Edmund H. Wellech and Walter C. Weber. Enough uses have been suggested for thin flakes

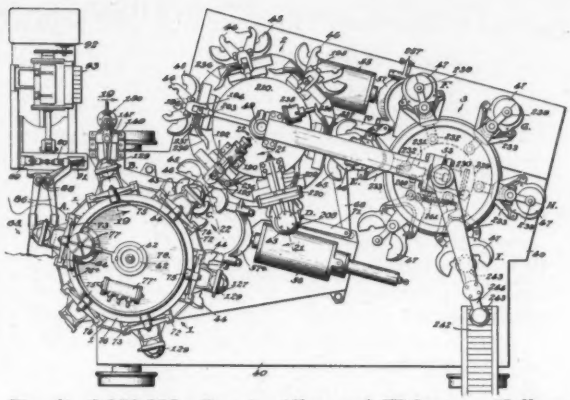


Fig. 3. 2,252,391: Benoit, Allen and Wideman. Hollow-ware machine with intermediate molds between the parison and finishing molds.

of glass to indicate that the commercial possibilities depond upon the development of cheap and reliable commercial production methods. P. E. Harth suggested in British Patent 449,239 that foliated glass be produced by blowing glass into bubbles until they break. Wellech and Weber point out that such bubbles vary in thickness from the base and that the flakes will tend to be slightly wedge shaped. They suggest instead that a tube of large diameter with very thin walls be formed and then shattered. Figure 4 omits the tube shaping aparatus and shows only the means for making the flakes. The tube is shattered by rotating blades 89, and a fan 86 draws off the flakes while lumpy debris is reclaimed for remelting. Patent 2,251,726 covers the method and 2,251,727 the apparatus.

James A. Lewis of Hartford City, Ind., received patent 2,251,847 (Sneath Glass Co.) for a glass pressing machine in which a rim portion of the mold stays in place for an interval after initial forming to prevent collapse of the rim.

Patents 2,253,276 and 2,253,277 to Thomas H. Jeffers of Paden City, W. Va., refer respectively to a pressing machine for tumblers and a feeding device. The pressing steps are illustrated by Figure 5. A measured gob is deliverd through the spout (at the left) into a female mold member 16, which at that moment is stationary under the spout. Then the mold advances to a point midway between the upright posts, at which position one of the male mold members is brought into position to shape the article. Subsequently the female mold moves on and another follows it. The hinged halves of the female mold are held together during charging and pressing by rails on each side of the pressing table, but these rails are terminated at the right end of the table to allow the mold to be opened for ware removal.

The Jeffers feeding device of 2,253,277 provides a gob-releasing plunger with a cam controled program which varies the size of successive glass charges so that ware of several different sizes may be successively molded.

A process and machine for uniting the halves of hollow glass blocks, was patented by Wm. Owen of Pittsburgh, (2,254,086 to Pittsburgh Plate Glass Co.). The halves, placed one above the other are passed through a preheating oven, then united by a direct vertical pressure and then cooled gradually for annealing. The form of furnace described has an annular rotary hearth.

Miscellaneous Processes

A lehr loader patented by Fred C. Link and Wm. E. Link of St. Louis, Mo. (2,252,937), removes a row of bottles from a narrow conveyor travelling counter to the lehr belt. The bottles are lined up before the lehr and moved toward it by the cross-spoke of a rotary frame which bears on the lower sides of the bottles through a roller. Another lehr loader or stacker patented by Harold A. Wadman of W. Hartford and Algy J. Smith of Hartford, Conn., (2,253,155 to Hartford-Empire Co.), takes the ware from the machine and the necessity for leaving it in the blow molds until cool enough to stand handling is one of the recognized "bottle-necks" in forming processes. The Wadman-Smith apparatus handles bottles by their necks and pauses enroute to the lehr to hold them over a perforated cooling plate through which air is blown. Further to expedite their removal from molds successive articles are moved in alternate paths and if desired in such a maner that one is being cooled while another is being stacked.

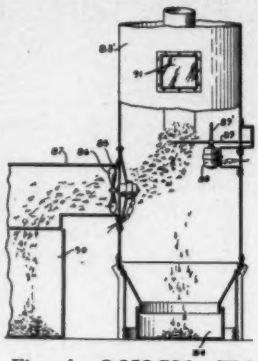


Fig. 4. 2,252,726: Wellech and Weber. Foliated glass is made by breaking up a thin tube.

A glass cutting tool was patented by Guy C. Wyman of Chatham, N. J. (2,254,162 to Landon P. Smith Inc., Irvington, N. J.). The ink printing process of patent 2,254,072 was assigned by John D. Jenkins, Wilkinsburg, Pa., to Pittsburgh Plate Glass Co.

The problem of handling the tiny pieces of flared glass tubing used for stems of small radio tubes, etc., was attacked by John Flaws Jr. of E. Cleveland (2,252,498, to General Electric Co.). His apparatus delivers them in a continuous heads-up line after receiving them in bulked non-oriented condition.

Plate and Sheet Glass

Supporting meansn for sheet glass to be heated for tempering continues to be a foremost field for invention. The latest patent is 2,252,703 assigned by Jacques Marie Darodes de Tailly of Thourette, France, to The American Securit Co., Washington, D.C. The glass is supported in the normal manner by tongs which grasp the top of the sheet. However, de Tailly points out that since the tension on the tongs is not exactly determined, some may be overlooked and thus increase the possibility of deforming the sheet. His correction shown by Figure 6, provides tongs which are attached to one end of a piboted arm carrying adjustable balance weights at its other end, in order to regulate the pull exerted by each tong on the glass sheet. As many tongs may be used as seems advisable to keep the load at any given figure.

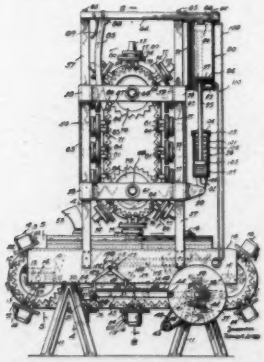


Fig. 5. 2,253,276: Tumbler press. Jeffers.

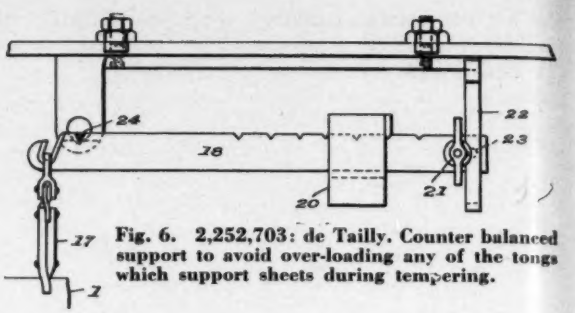


Fig. 6. 2,252,703: de Tailly. Counter bulanced support to avoid over-loading any of the tongs which support sheets during tempering.

Eastman Kodak Co. has patented an optical device for measuring the flatness of glass, (2,253,054 to Clifton M. Tuttle and Randle V. Cartwright, Rochester).

Patent 2,252,787 to Roger G. Sarver of Toledo (Libbey-Owens-Ford Glass Co.) describes an apparatus for cleaning edges of laminated sheet glass, and 2,254,075 to Paul C. Lawson of New Kensington, Pa. (Pittsburgh Plate Glass Co.), is concerned with equipment for washing plastic sheets. Another patent assigned to the latter company is Wm. O. Lytle's 2,254,044 for a type of building construction using tempered glass plates.

Glass Wool and Fiber

A particular design of air filter utilizing glass fibers was patented by Frank L. Myers of Toledo (2,252,724 to Owens-Corning Fiberglas Corp.). Another Owens-Corning patent, 2,252,157 granted to Wm. M. Bergin of Granville and Allen L. Simison, Newark, Ohio, claims a "strong, semi-rigid, resilient, light weight (insulating) bat comprising an unfelted mass of glass wool fibers, and a treating material disposed over the fibers" which includes a hydrocarbon oil as a lubricant and a Bakelite type of binder.

The property of water-repellence, which current theory holds is needed for fiber household insulation, is given to mineral wool by coating it with a mixture of mineral oil, aluminum stearate, and an oxide or carbonate of lime or magnesium. This is disclosed in patent 2,252,169 granted to Walter V. Cullison of Wabash, Ind. (American Rock Wool Corp.).

R. CAMPBELL THOMPSON

Dr. R. Campbell Thompson, who was known to many glass technologists as the author of "On the Chemistry of the Ancient Assyrians," died of heart failure after coming on duty with the Home Guard (somewhere in England) on the night of May 23. His success in deciphering Cuneiform tablets has given the interesting story of glass making in ancient Assyria. The ceremonial ritual accompanying the building and starting of the furnace, the composition of frit, the preparation of wood used as fuel and the glass melting process as used in Assyria in 600 B.C. are known to the modern world today through his efforts. He was the last representative in England of a phase of Assyriology which converted that study from a discovery into a science.

• The American Society of Mechanical Engineers will hold their Fall meeting at Louisville, Ky., October 12-15, with headquarters at the Brown Hotel.

CURRENT STATISTICAL POSITION OF GLASS

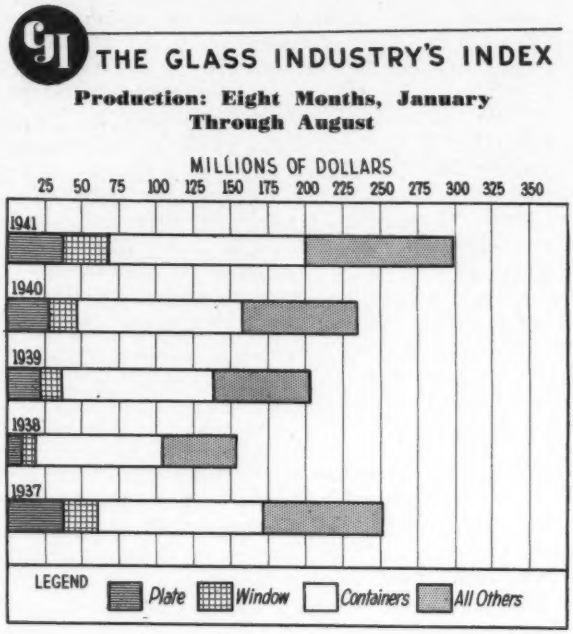
August witnessed the usual seasonal increases in the glass industry with gains reported in production, employment and payrolls; as a result new records were established. According to THE GLASS INDUSTRY Production Index, output during August totalled $41,000,000, bringing the January-August cumulative total up to $297,000,000 as compared to $233,000,000 in 1940's corresponding period.

Plate glass production during August totalled 14,125,169 square feet, according to the Plate Glass Manufacturers of America. This was 13 per cent greater than the previous month's total and the volume reported for August 1940. During the first 8 months of 1941 plate glass output amounted to 136,142,000 square feet as compared to 96,660,000 square feet in last year's corresponding period—an increase of 40 per cent.

Window glass production during August totalled 1,267,472 boxes which was slightly less than the July total, but exceeded August 1940 by 27 per cent. Cumulative figures for the January-August period indicate an output of 10,910,000 boxes, or a gain of 27 per cent over last year. During August the window glass industry operated at 78 per cent of capacity.

Glass container production during August attained the record volume of 6,790,554 gross according to the Glass Container Association of America. This was 2 per cent more than the computed capacity of the industry, resulting in an 8 per cent climb above the July peak and a gain of 34 per cent over August 1940. During the first 8 months of this year production totalled 44,831,000 gross as compared to 36,556,000 gross in last year's corresponding period. These figures indicate that the activity in this branch of the glass industry has been 22 per cent greater than last year.

Shipments of glass containers during August increased 7 per cent over the previous month's total to 6,800,554 gross. This was 46 per cent greater than the August 1940 total. The outstanding gains over 1940's corresponding month were reported for beer bottles, liquor ware, and domestic fruit jars, all of which more than doubled in volume. Sales of domestic jelly glasses increased 60 per cent and milk bottle volume rose 44 per cent; other increases ranged from 15 to 36 per cent.



Cumulative figures for the January-August period indicate that this year's shipments have exceeded 1940's volume by 29 per cent, having recorded a total of 43,570,109 gross. An analysis of the trends in individual lines reveals that sales of domestic fruit jars have increased 86 per cent, domestic jelly glasses 39 per cent, general purpose ware 38 per cent, liquor ware 33 per cent, pressure and non-pressure ware 30 per cent, narrow neck food containers 29 per cent, milk bottles 30 per cent, wide mouth food containers 28 per cent and beer bottles 26 per cent.

Inventories of glass containers as of August 31, 1941, totalled 8,051,959 gross, or 17 per cent less than last year's corresponding figure. Stocks of all types of ware were lower with the exception of beer bottles, which were up 12 per cent. Declines ranged from 6 per cent to 49 per cent.

Miscellaneous glass products produced during August were valued at $14,000,000—an increase of 40 per

CURRENT GLASS CONTAINER STATISTICS

(ALL FIGURES ARE IN GROSS)

Types of Wear	*Production* Aug., 1941	*Production* Aug., 1940	*Shipments* Aug., 1941	*Shipments* Aug., 1940	*End of Month Stocks* Aug., 1941	*End of Month Stocks* Aug., 1940
Food Containers (Narrow neck, wide mouth and pressed)	2,303,851	1,928,439	2,169,902	1,699,941	2,097,084	2,502,600
Pressure and Non-Pressure Wear	471,092	308,131	480,264	304,518	445,363	574,906
Beer Bottles	388,864	224,637	429,760	186,254	582,558	531,374
Liquor Ware	944,874	573,436	922,100	455,111	1,347,186	1,501,539
Medicinal and Toilet Ware	1,756,596	1,428,429	1,826,145	1,362,785	2,548,637	3,178,281
General Purpose	411,210	314,336	409,849	301,856	465,230	586,515
Milk Bottles	315,061	200,646	300,881	208,314	307,410	325,513
Fruit and Jellies	171,249	61,133	239,007	106,767	214,993	415,881
All Other	27,757	23,296	22,646	18,963	43,498	37,929
Total Industry	6,790,554	5,062,483	6,800,554	4,644,500	8,051,959	9,654,538

cent over August 1940. During the January-August period this output totalled $98,000,000 as compared to $74,000,000 last year.

Machine-made tumbler production during August amounted to 4,878,616 dozens, which was 27 per cent greater than in 1940's corresponding month. During the first 8 months of this year tumbler output totalled 34,757,928 dozens—16 per cent above last year's level. Shipments during August increased 27 per cent over August 1940 to 4,826,108 dozens, bringing the January-August total 17 per cent above last year's level to 34,582,405 dozens. Stocks on hand August 31, 1941, amounted to 7,871,940 dozens which was a gain of 4 per cent over last year's corresponding figures.

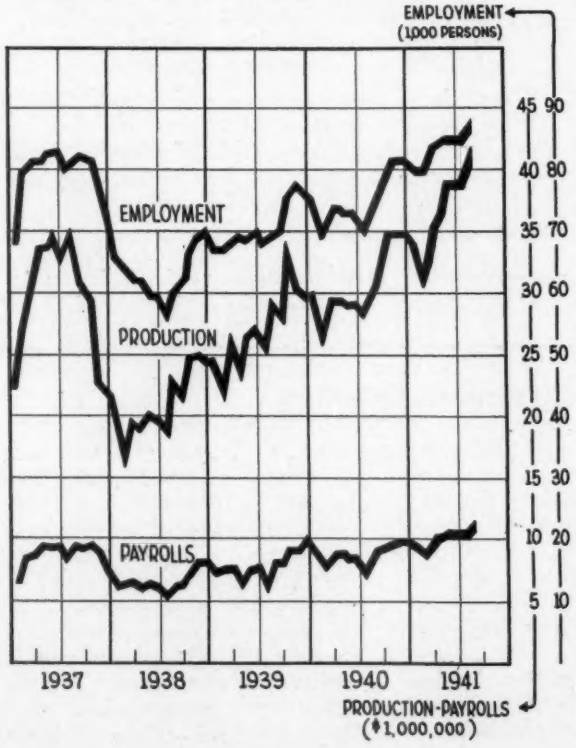
Manufacturers' sales of machine-made table, kitchen, and household glass ware totalled 3,856,685 dozens, or 16 per cent more than a year ago. For the 12 month period ending August 31, 1941, this trade amounted to 37,617,162 dozens, which was 10 per cent greater than last year's total.

Employment and Payrolls: Approximately 2,000 persons were added to the glass industry's payrolls during August, bringing the total employment up to about 88,000 persons. This compared to 76,000 in August 1940.

Payrolls in the glass industry during August were estimated at $11,500,000—a gain of $500,000 over the previous month and about $3,000,000 more than last year's corresponding figure. During the first eight months of this year glass manufacturers paid out $84,000,000 in wages; last year's comparable total was $66,000,000.

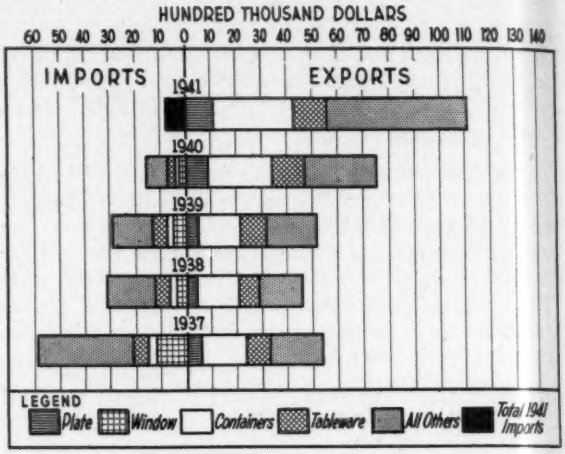
THE GLASS INDUSTRY'S INDEX

Monthly Trends Through August, 1941



THE GLASS INDUSTRY'S INDEX

Foreign Trade: Seven Months, January Through July



Foreign Trade: Exports of glass and glass products during July amounted to $1,188,000, according to official figures released September 20th by the Department of Commerce. This was 16 per cent less than the June total, but was slightly above the July 1940 figure. The dip from the June level was largely due to a 19 per cent decrease in glass container shipments and declines of 10 per cent and 9 per cent respectively in plate glass and illuminating glassware. Window glass and glass tableware volume was at the previous month's rate.

Comparison of these July figures with last year's corresponding figures indicates that although the totals were about equal, there were wide fluctuations in individual lines. Plate glass was down 46 per cent, tableware 10 per cent, containers 6 per cent and illuminating ware 4 per cent; these were counteracted by a 58 per cent increase in window glass. During the first 7 months of this year, glass exports totaled $11,205,000 as compared to $7,259,000 in 1940's corresponding period.

Imports of glass and glass products during July dropped 20 per cent below June's volume to $94,000; this was 51 per cent less than 1940's comparable total. During the first 7 months of 1941 imports amounted to $772,000 as compared to $1,630,000 last year.

FOREIGN TRADE STATISTICS

(Values in $1,000)

Exports	*July* 1941	*June* 1941	*July* 1940
Plate	110	124	202
Window	144	145	91
Containers	352	433	331
Tableware	172	167	195
Illuminating ware	51	56	53
All other	359	485	312
Total	1,188	1,410	1,184
Imports			
Total	94	118	192

FEAR PROPAGANDA CAMPAIGN THREATENS GLASS TUMBLER INDUSTRY

Today the glass industry is drowsing complacently. Fat defense orders are rolling in. Business is good. The future? Why borrow trouble?

Yet a vigorous competitor is thinking hard about that *future*, and striving to undermine the established place of glass in consumer preference.

Snug and smug behind their Maginot Line, the Allies once laughed at the possibility of the enemy cracking that "impregnable" position. Likewise, today the prospering glass industry considers itself safe from any attack by competitors present or future. Sure of their product's many advantages, glass men fondly believe that no rival can take away their markets. But that rival is working day and night to build up an acceptance for their product as a substitute for glass.

With persistence, streamlined efficiency and thoroughness, the paper industry is spreading fear propaganda to displace glass with paper in every market in the country. Chief agent for the dissemination of such shudder-and-shake ideas is the "Public Health Committee of the Cup and Container Institute," with headquarters in New York City. This is a high-sounding, disinterested name for an organization with a wholly selfish purpose.

It is the object of this "Committee" to replace glass with paper in all soda fountains, restaurants, offices, factories—anywhere and everywhere. The "Committee" is amply financed, alert to twist every fact and half-truth to its advantage, it is making progress. And the glass industry is "too busy" to be alarmed.

A major instrument in the "Committee's" campaign to forbid the use of drinking glasses throughout the nation is a monthly magazine, *Health Officers News Digest*. According to a recent issue, "almost everybody who is anybody in public health work" receives this publication. "It's fun, it's informative, it's *news!* Coming to you each month, it keeps you abreast of developments on the dish washing and sanitization front. And it costs you nothing!"

Health officers, federal, state and local, may get the *News Digest* easily, the "Committee" tells them. "Just drop us a note and we'll do the rest. . . You can have the *News Digest* sent to your fellow health workers if you wish. Be sure to give individual names and addresses, rather than requesting bulk copies. It's the sanitarian's Bible."

Major part of the *News Digest's* editorial content is devoted to spreading fear. Specifically fear of the drinking glass. After reading one or two issues a skeptic might wonder how any Americans are left alive, for—if one is to believe the *News Digest*—all drinking glasses are worse than the Black Plague, more loathsome than cesspools. Every issue lists on the first page the following diseases:

"Mumps, measles, influenza, dipththeria, tuberculosis, scarlet fever, common colds, German measles, lobar pneumonia, Vincent's angina, whooping cough, cerebrospinal fever."

All of these, the *News Digest* repeats month after month, "may be contracted by direct personal contact, by droplet infection, or indirectly 'in food and drink, by hand to mouth infection, or by vectors as cups, spoons, and other things that are mouthed.' (p. 1. Preventive Medicine and Hygiene; M. J. Rosenau.)"

With this scare-the-pants-off-'em preface, the *Digest* then proceeds to impart its news. Some of the articles it publishes are of genuine value to health officers. Cleverly blended in with them, however, are a constant succession of items designed to discredit glass. Three samples will indicate the general tone of these news tid-bits:

"*Mentone, Indiana*—As a precautionary measure to prevent the spread of polyiomyelitis all concessionnaires will be required to serve food and drinks in single-service paper utensils, according to a statement issued by County Health Officer Garber before the Community Fair opened."

"*Coalinga, California*—Taking to heart the plea of public health officials to 'make America strong by making Americans stronger and protect the public from communicable diseases,' the proprietor of a soda fountain and lunchroom here discarded all his glassware and equipped his establishment complete with '100 per cent sanitary paper service.' The public, he said, is guaranteed the 'ultimate' in service."

"*Durham, North Carolina*—As the opening signal of a drive to compel sanitation in soda fountains, restaurants and other public eating places, four eating establishments were barred to the public last month. Owners paid fines of from $10 to $25 and were told they could reopen only after they had complied with local sanitary ordinances. 'Other sanitation law violators will be indicted,' Health Superintendent Epperson declared, 'until all backsliders have improved or gone out of business.' Places are graded by inspectors, operators being credited with 25 points if they serve drinks in individual paper cups."

Note that nowhere does the *News Digest* come out with a barefaced assault on glass drinking glasses. Suggestions, subtle insinuations are the methods used. Remember, the *Digest*, as it boasts, goes to "everybody who is anybody in public health work" every month. Can it be doubted that over a period of time such innuendoes have a powerful effect in forming health officers' opinions and actions?

Of course, the glass industry is just as interested in protecting public health, in preventing disease, as is the "Public Health Committee of the Cup and Container Institute." But for the most part, the glass industry keeps silent. Not so the paper cup and container institute. By adroit publicity it has fixed itself in the minds of many health officers as the sole champion of sanitation.

In the disguise of a courageous Knight of Purity it rides forth to slay the dragon of filth which—it perpetually suggests—*always* is found where glass is used for drinks. Through wily maneuvering it has placed advocates of glass in the position of defending contamination. Is it any wonder, then, that paper has encrouched on the use of glass in one market after another?

The *News Digest* is by no means the only weapon with

(*Continued on page* 450)

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	....	....
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00–16.00	18.00
Borax ($Na_2B_4O_710H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027 –.0295
Powdered	In bags, lb.	.024	.0295–.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054 –.0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.950–.975	.10
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00–13.25	
40 mesh	ton	11.50–13.75	
Granular	ton	11.75–14.00	
Semi-granular	ton	11.00–13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96–98% (max. SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	32.00	....
In bags	ton	33.60	45.00–48.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0835	....
In 5 Ton lots	lb.	....	.0875
Less than 5 Tons	lb.	....	.0925
Lime—			
Hydrated ($Ca(OH)_2$–MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO–MgO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$–$MgCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$–$MgCO_3$) 16x20 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.50	16.00
Potassium carbonate—			
Calcined (K_2CO_3) 96–98%	lb.	.065	.0675
Hydrated 80–85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	18.00–20.00	25.00
in bulk		16.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	3.00–3.40
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.4675	1.465
100 lb. bags		1.475	1.50

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.026–.029	.04
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.15	.15½–16
Arsenic trioxide (As_2O_3) (dense white) 99%	....	....	.095
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6)	lb.	....	....
Tin Oxide (SnO_2) in bbls.	lb.	....	.55
Titanium Oxide (ceramic grade)			
In bags	lb.	.14½	.14¾–.15¼
In barrels	lb.	.14¾	.15 –.15½
Zinc Oxide (ZnO)			
American process, bags	lb.	.07	.07¼
White Seal, 150 lb. bbls.	lb.	.09	.09¼
Green Seal bags	lb.	.08¼	.08½
Domestic White Seal bags	lb.	.08¾	.09
Red Seal, bags	lb.	.07¾	.08
Zircon			
Refined Granular (Milled .01–.02c. higher)		.06½	.07–.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40–1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10–1.15
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.25–.28
Chromite (99% through 200 mesh)	ton	55.00	58.50
Chromite ore (air floated)	ton	55.00	58.50–73.00
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.20–.22
Black (CuO)	lb.	....	.19–.22½
Black prepared	lb.	....	Open price
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.06–.10
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035–.05
Lead Chromate($PbCrO_4$) in bbls.	lb.	....	.145
Lithium Carbonate	lb.	....	1.25
Manganese, Black Oxide (Caucasian)			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35–.40
Nickel monoxide (NiO), green	lb.	....	.35–.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	....	.09¾–.10
Powdered	lb.	....	.10¼–.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.21–.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07¼	.07¼–.07¾
Sodium chromate (Na_2CrO_7) Anhydrous	lb.	.08⅛	.08⅞–.09⅛
Sodium selenite (Na_2SeO_3)	lb.	....	1.50–1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70–4.10
Flowers, in bags	Per 100 lb.	3.00	3.35–3.75
Flour, heavy, in 250 lb. bags	Per 100 lb.	2.90	3.25–3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.55
Yellow orange	lb.	....	1.65

Polishing Materials

		Carlots	Less Varlots
Emery, Turkish	lb.	.105	.08
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	open price
0, 0½, 1, 1½	lb.	....	open price
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb	.02¼	.03½
Rouge, Red	lb.	.18	.16
Black	lb.	.15	.18

Parts of two of the many batteries of ball mills working 24 hours a day grinding "Ceramic" Colors to exact fineness to assure efficient operation in the customer's plant.

"Ceramic" CAN SUPPLY YOUR NEEDS!

"Ceramic's" production facilities, experienced personnel and reserve stocks have been geared to meet the rising needs of the glass industry.

Now, as always, "Ceramic" Colors and Chemicals — pre-tested under actual production conditions — assure dependable, efficient performance in your plant.

Specify "Ceramic" Colors and Chemicals for availability as well as for uniformity and dependability.

GLASS

Vitrifiable Colors for Banding, Spraying, Screening; Fluxes; Batch Colors; Alkali Resisting, Acid Resisting, Satin Finish, High Fire Convexing, Low Fire and Squeegee Colors; White or Colored Weather Resisting Enamels; Colored or Crystal Ices; Chemicals and Decorating Supplies.

"Ceramic" COLORS

CERAMIC COLOR & CHEMICAL MFG. CO.

NEW BRIGHTON, PA., U.S.A.

NEW EQUIPMENT AND SUPPLIES

NEW "DRY" OILS BY ESSO

New oils containing colloidal graphite and designed for high temperature lubricating (above 400°F) have been added to the line of Esso industrial lubricants. Designated by the trade name of "Van Caloria," these are being distributed by Standard Oil Companies of New Jersey, Pennsylvania and Louisiana; by the Colonial Beacon Oil Company; and by Penola, Inc.

At the high temperatures for which the lubricants are designed, the oil gradually vaporizes leaving no residue from the oil itself but only a fine film of "dry" colloidal graphite. Under friction and heat this graphitic film is absorbed by the surface material, forming what is known technically as a graphoid surface. Lubrication from that point on is entirely "dry" until the supply of oil is renewed. Thus the graphite prevents actual metal-to-metal contact until a new supply of Van Caloria reaches the bearing surfaces.

The new Van Caloria oils are available in several viscosities to suit varying lubricating conditions and methods. They range in viscosity from light-bodied liquids to highly viscous types. The oils are black in color, due of course, to the graphite suspended in the oils. They may be applied by any of the conventional methods, including spray, oil can, mechanical lubricator, pressure gun, etc., depending on the design of equipment and operating conditions.

VIBRO-INSULATORS

Three new Vibro-Insulators, the devices of rubber and metal which decrease vibration and noise in machinery of many types are announced by the B. F. Goodrich Company, and listed as Types 14, 33 and 36. They are for general application.

Type 14 is recommended for a load in vertical shear of 80 pounds per square inch, deflection in shear of one inch at a loading of 80 pounds, and minimum disturbing frequency at this deflection 470 per minute. This type also is supplied with the rubber in compression, by placing the metals in a horizontal position. The maximum recommended load under compression is 250 pounds per inch, deflection at that loading of 5/16th inch and the minimum disturbing frequency at that deflection 850 per minute.

In Type 33 the rubber is applied only in compression, with the maximum loading 150 pounds and deflection at that point 5/32nd inch, with the minimum disturbing frequency at that deflection 1200 per minute.

Type 36 is best adopted for work with the rubber in compression, although it can also be applied in shear. With 35 and 50 durometer hardness loading beyond 20 per cent of the rubber thickness, or .175 inch is not recommended. Under this load the minimum disturbing frequency is 1250 per minute and the load necessary to deflect 35 durometer mounting is 100 pounds and for 50 durometer mounting 85 pounds. These are maximum load limits with lower loads recommended where possible, especially where disturbing frequencies are greater than 1250.

STUDEBAKER HYDRAULIC VISE

A new hydraulic vise has been introduced by the Studebaker Machine Co., Chicago, Ill. The vise is capable of developing pressures up to 5 tons between the jaws and is operated entirely by foot control, permitting the use of both hands in setting up and removing work. The unit is self-sufficient. Pressure to close the jaws is controlled by a foot pedal pump arrangement in a pedestal mounted on the floor. The latter is connected with the vise proper by a steel tube which carries the hydraulic fluid to a ram behind the back jaw and moves it forward. The front jaw is stationary. Stepping on one pedal moves the vise jaw to contact against the work. A second pedal applies pressure up to 5 tons. A third pedal releases the jaw.

Construction is all semi-steel. The hydraulic pump is precision fitted to insure accurate operation and long life. The sliding jaw and base are accurately machined to insure an accurate fit of the two jaws. Pump and ram cylinders are honed and polished.

The vise mounts horizontally on any type of bench as well as vertically on wall or post. In addition, it can be mounted on a portable stand as a movable, self-contained unit. Special jaw faces can be applied.

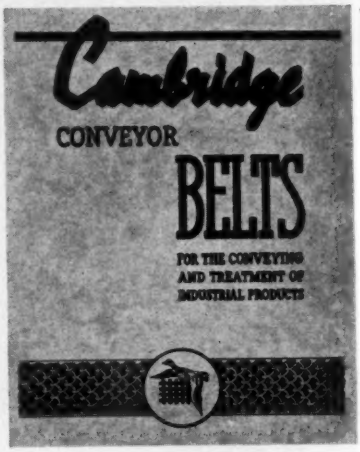
"FALCON" ELECTRIC FURNACES

A new line of "Falcon" electric box type and muffle type furnaces have been announced by H. O. Swoboda, Inc., New Brighton, Pa. The furnaces are arranged for either floor or bench mounting and are equipped with heavy alloy heating elements to assure efficient, long-life operation at temperatures up to 2300° F. Heating elements are supported in high grade refractories arranged in top, bottom, side and rear walls of the furnace. The furnace chamber is completely surrounded by durable block type insulation.

These furnaces are being used for testing metal samples, melting of glass samples, burning of refractories, oxidation determinations, testing of vitreous enamels, for hardening and tempering, and many other widely varying applications.

Model BRP, without muffle, has a chamber 9 in. high, 12 in. wide and 36 in. deep, with a 16 kw. capacity suitable for 2000° F. maximum operating temperature. Automatic temperature controls are mounted on the side of the furnace, completely wired for connecting to power supply. The furnace is equipped with a foot-treadle operated door mechanism.

The furnaces are made in various standard sizes and can also be supplied in special sizes according to customer specification.



CATALOGS RECEIVED

The Cambridge Wire Cloth Co., Cambridge, Md., have announced their new catalog, "Cambridge Conveyor Belts," for the conveying and treatment of industrial products. The catalog contains 140 pages and is said to be the most complete reference on woven wire conveyor belts ever published. Special sections, fully illustrated, appear on installations in the food industries, the glass and ceramic industries, the metal industries, the processing industries, and many others.

There are chapters on metals and alloys, conveyor design, installation and operation, tensile strengths, and full scale illustrations which will be of utmost value to the plant engineer.

Brown Instrument Co., Philadelphia, Pa. Bulletin No. 74-2, "Brown Furnace Pressure Controller." A complete description of the control system is given and also of the parts that go to make up the system, such as the indicating controller, power cylinder and diaphram motor. Photographs of the units are included. A schematic diagram shows how the system should be hooked-up.

Reinhold Publishing Corp., New York City. The 26th annual edition of the "Chemical Engineering Catalog." The catalog, known as the Process Industries' Catalog, is a standard reference work for chemical engineers, factory managers, operating executives and purchasing agents. The catalog was inaugurated by the American Institute of Chemical Engineers in 1915.

American Manganese Steel Division, Chicago, Heights, Ill. Bulletin No. 941-W, Amsco Welding Products for reclamation, hard surfacing and repairing of ferrous equipment parts.

ACS MEETING

(*Continued from page* 429)

while Höefler and Dietzel expressed the reaction as:

$$\underset{\text{(blue)}}{FeO} + Na_2 \longrightarrow \underset{\text{(red?)}}{FeSe} + Na_2O$$

It was the purpose of this study to show that while the above investigators are correct in their observations their postulated reactions and ferrous selenide compound formation are not responsible for the color changes observed. Instead, the phenomena involved can be readily explained by a simple oxidation-reduction reaction.

The method employed in this investigation was to melt down at a standard temperature and under known atmosphere a series of simple soda-lime-silica and potash glasses both with and without known amounts of the various colorants concerned. The resulting glasses were then annealed to the same degree, ground and polished to equal thickness and then spectral transmissions in the visible and infra-red regions measured. Extinction values were then obtained from this data.

The extinction values of the various glasses were plotted in the form of curves. By an analysis of these curves it was shown that the formation of an iron-selenium compound did not take place but that the color changes followed the following reactions:

$$\underset{\text{(green)}}{4\,FeO} + Na_2SeO_3 \longrightarrow \underset{\text{(yellow)}}{2\,Fe_2O_3} + \underset{\text{(red)}}{Se} + Na_2O$$

This reaction indicates that the colorless selenite ion reacts with the green ferrous ion and produces the less colored ferric ion plus the red elemental form of selenium. The red color of the elemental selenium then physically compensates the remaining green ferrous ion.

Alumina-Silica Relationship in Glass. *By Hurd W. Safford and Alexander Silverman, University of Pittsburgh.*

The effect of alumina on certain physical properties of glass such as chemical durability, hardness, thermal endurance, viscosity and the like indicates that the behavior of alumina is similar to that of silica. The object of this study therefore was to determine the position of alumina in the random network picture of glass.

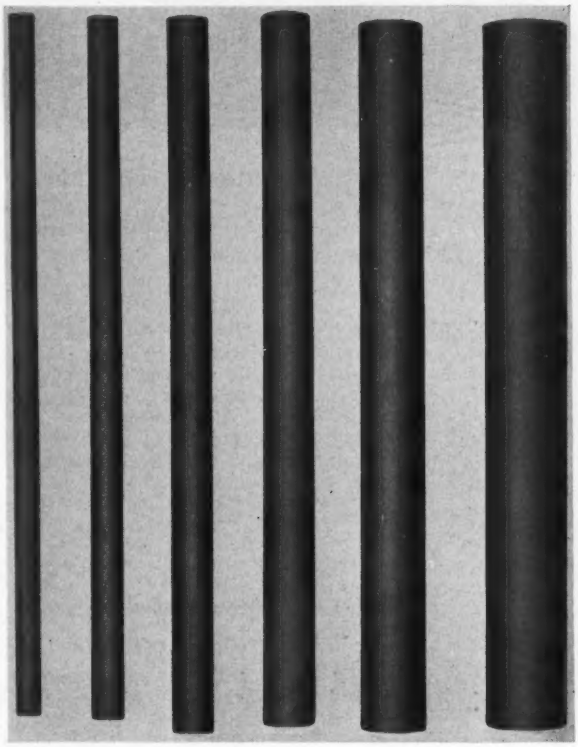
A description of the materials used and the method of preparing the alumina-containing glasses, and the methods used in measuring the physical properties of the glasses was given. The data so obtained was subjected, as a mathematical analysis and pertinent information regarding the state of alumina in glass deduced.

The Lorentz-Lorenz equation was used to evaluate partial molecular refractions of the component oxides in glasses of the system Na_2O—CaO—SiO_2—Al_2O_3 and in certain crystalline alumina-silicates. It was shown that these refractions are sensibly additive both for the glasses and for the isomorphous series of soda-lime feldspars. Partial molecular refractivities of Al_2O_3 in the experimental glasses closely paralleled those calculated for crystals in which the coordination number of Al is known to be four but showed considerable deviation when compared to those calculated from crystals in which the coordination number is six. In addition, the calculated interionic distances Si—O and Al—O showed good agreement with known measured values obtained on substances in which the Al and Si atoms assume four-fold coordination.

It was concluded that the aluminum atom isomorphously replaces silicon in the random tetrahedral network and that the cation Na+ and Ca++ are situated in the interstices of this open structure. This position of the aluminum atom in the silicate structure readily explains the similarity of the behavior of alumina and silica.

HAVE PATENT for transformation of window glass or raw wire glass to plate glass with industry cost $.05-$.06 per square foot minimum for installation about $10,000. Have small capital. Search partner or connection with glass jobber or mirror maker. Box No. 42, The Glass Industry, 11 West 42nd St., N. Y. C.

Malleable Iron Rods for plugging Moulds



1/8″ 3/16″ 1/4″ 3/8″ 5/8″ 1/2″ x 6″

IN the manufacture of Malleable Rods a "white iron" is produced Fe3C. The carbon is present in the combined form. The "white iron" castings are annealed or graphitized so that the final structure consists of ferrite (Fe) and free carbon (C) which is in the form of "temper" carbon.

This material is very soft and will pein readily.

Machinability

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MODERN GLASS is the result of new, improved technology—and new types of basic materials. Here are outstanding factors in this "tooling up" of glass production — all BETTER MATERIALS produced by Solvay:

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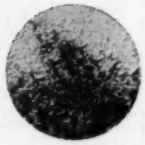
Especially developed by Solvay for the glass industry. Used to produce special glass such as optical glass and fine stemware, this product was a major development for the glassmaker. Dust from potassium carbonate is a serious nuisance to workers and is particularly damaging to the costly glass furnaces. It decreases the life of expensive fire brick, lowers the efficiency of heat transfer and otherwise seriously interferes with equipment and processing. Solvay Calcined Potassium Carbonate *is free from dust* and therefore prevents costly losses. Its "homogeneous" physical characteristics, as in the case of Solvay Dustless Dense Soda Ash, result in important production savings.

SOLVAY DUSTLESS DENSE SODA ASH—*Especially developed by Solvay for the glass industry.* Highly pure, highly uniform, for all practical purposes free from dust. Dust interferes with processing and is a source of irregularities in the glass. Physical characteristics of this product are so determined with respect to density and granulation, that there is perfect blending with other ingredients to produce a purer glass. Prevents loss of valuable materials and helps maintain control over glass melts, which is an important key to quantity production.



SOLVAY GRANULAR HYDRATED POTASSIUM CARBONATE 83-85%
This form of Potassium Carbonate is available for those who prefer a hydrated type. A high quality granular product, also essentially free of dust.

AN OUTSTANDING TECHNICAL SERVICE FOR GLASSMAKERS—Solvay is particularly well equipped to render technical assistance on glassmaking problems as they relate to the use of alkalies. Prompt and individual attention by recognized glass technologists is given all inquiries.

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FEAR PROPAGANDA CAMPAIGN

(*Continued from page* 445)

which the "Health Committee" seeks to undermine confidence in glass. Editors of food service publications are under a consistent barrage of publicity handouts which, according to this or that "authority," inform them that drinking glasses are dirty and paper cups are spotless. Under the guise of news, many editors pass along these suggestions to their readers. And before long the glass industry will groan because customers show increasing sales resistance!

Films, too, are included in the campaign of fear. "'In Your Hands,' a new sound slide-film for the instruction of food handlers," is distributed by the "Health Committee" for a modest price. As described in *News Digest*, it is "a film that tells simply yet dramatically what every food handler—and every customer—should know about dish washing and sanitization."

Produced with the cooperation of 24 prominent public health officials and health educators, 11 of whom actively collaborated on the script, *News Digest* asserts, the film's showing time is 24 minutes. It is available to health departments for the instruction of food handlers at the nominal cost of $4.37. Or it may be rented for three days for $1; three to seven days for $2. Also, it "may be shown to civic and club groups to stimulate interest in restaurant sanitation."

"In Your Hands" was first distributed last year. Since then it has been shown to untold thousands of people all over the United States. As long ago as 1936, however, the "Public Health Committee" was actively fostering fear of drinking glasses. A booklet published by it in that year containing a compilation of "Laws versus the Common Drinking Cup" has been widely circulated. A foreword to these laws pointed out:

"Bad as the common cup is, the popular modern vehicle for the transfer of saliva is primarily the common eating and drinking utensil in public eating and drinking places. . . ."

"It has been shown that the ordinary methods of dishwashing as used in large numbers of public eating places do not remove the organisms which are usually found in the human mouth, or those customarily associated with diseases which enter the system through the mouth. Improved methods of dishwashing and the *substitution wherever possible of individual sanitary paper service* will be necessary to eliminate the present free exchange of mouth secretions which is everywhere taking place."

Two years later the "Public Health Committee" published a supplement to this compilation of "Laws versus the Common Drinking Cup." A preface stated:

"The communities whose regulations are herein quoted have recognized, and have attempted to do something about the *modern* problem of drinking sanitation. To these communities it is apparent that you can no more banish the dirty drinking glass with a common cup law than oppose a mechanized army with bow and arrow."

"All or nearly all the laws incorporate a provision that single service in paper may be provided as the single alternative to glass sanitization and, in a few instances, no alternative to paper service is permitted. . . So far so good. . . Although paper service is everywhere acceptable and in practice approved, not every ordinance contains a provision for its use."

Thus, in so many words, the paper cup and container industry sets forth its program: Abolition by law of the drinking glass in every public place and the substitution of paper.

The Institute and its supporters who keep it well supplied with funds, naturally do not expect to achieve this goal of absolute monopoly immediately. Their program is a long-term one to be attained little by little. By spreading fear, though, they anticipate eventual conquest. Results prove that they are making headway, for states and communities are gradually adopting such laws.

What would such a conquest mean to the glass industry? It would mean wiping off the books as customers every restaurant, cafeteria, hotel, soda fountain, lunch counter, road house, tavern, roadside stand, school, industry and institutional lunchroom.

Should the paper industry accomplish its avowed goal, glass would no longer be a competitor. Present day arguments of price, durability, superiority, etc., would be totally worthless. Customers could not even listen to a glass salesman. Under the law they would be compelled to use paper.

In the face of this persistent, intelligently directed campaign, the glass industry cannot afford to remain slothfully silent. Perversion of facts, misconceptions, semi-truths must be met with vigorous reply.

Now is the time for the glass industry and allied industries to apply that "ounce of prevention." A sound, long-term program of education of the public and health officials is vital. It is not too late. Tomorrow it may be.

URBANA GLASS CONFERENCE DATES CHANGED

The dates for the Sixth Conference on Glass Problems have been advanced to Friday, November 14, and Saturday, November 15, instead of November 7 and 8 as previously announced in the September issue of THE GLASS INDUSTRY. The Conference is to be held under the joint auspices of the Department of Ceramic Engineering, University of Illinois, Urbana, Illinois, and the Chicago Section of the American Ceramic Society.

N. Y. CERAMIC ASSOCIATION

The Eighth Annual Meeting of the Ceramic Association of New York will be held on Friday, October 17, in the Ceramic Building of the New York State College of Ceramics, Alfred, N. Y. The program will consist of reports on the research work of the Ceramic Experiment Station for the past year, and a question forum on ceramic engineering.

NATIONAL SAFETY CONGRESS

The 1941 National Safety Congress and Exposition will be held at The Stevens Hotel, Chicago, Ill., October 6-10. The theme of this year's Congress is "Help Defense—Stop Accidents." About ten thousand safety leaders are expected to attend the 30th annual Congress. There will be 552 program participants and 162 sessions.

The Congress this year is unusually significant and timely, since President Roosevelt recently called upon the National Safety Council to lead a nationwide campaign against accidents which are hampering the national defense program. The Congress will devote much of its attention to the organization of this campaign.

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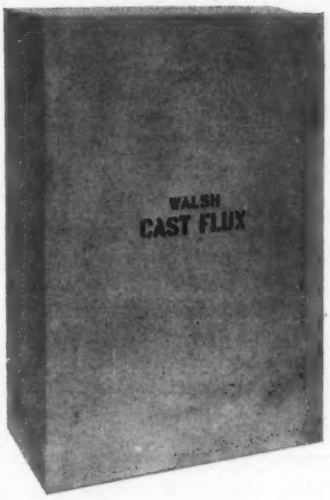

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Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

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ALANSON B. HOUGHTON

Mr. Alanson B. Houghton, former Ambassador to Germany and Great Britain, and a leader in the glass industry in the United States, died at "The Meadows," his summer home, at South Dartmouth, Mass., September 16. The former Ambassador was 78 years old. He was born in Cambridge, Mass., October 10, 1863.

Following an education at Harvard, with supplementary studies at Paris and Berlin, Mr. Houghton grew up in the glass business in which his grandfather and father had pioneered. At the turn of the century, Mr. A. B. Houghton was responsible for scientific advances in the company, which since has become the world's largest producer of technical glass products. For the Corning Glass Works, he served successively from 1889, becoming second Vice President in 1903, President in 1910, and subsequently occupying the positions of Chairman of the Board and Chairman of the Executive Committee.

Mr. Houghton was formerly a Director of the Metropolitan Life Insurance Company and President of the Board of Education of Corning, N. Y. He was twice a presidential elector and was a member of the Sixty-Sixth and Sixty-Seventh Congresses from the Thirty-Seventh District of New York. He resigned from Congress to become Ambassador Extraordinary and Minister Plenipotentiary to Germany in February 1922. From this post, he resigned in 1925 and was thereafter appointed Ambassador to Great Britain. Mr. Houghton was also Chairman of the Institute for Advanced Study at Princeton University, and was Treasurer of the Carnegie Endowment for International Peace.

The former Ambassador is survived by his widow, Adelaide Wellington Houghton, three daughters, Mrs. Glen W. Cole, Mrs. Matilda Anderson, and Miss Elizabeth Houghton. A son, Amory Houghton, is Chairman of the Board of the Corning Glass Works.

C.G.W. GETS INJUNCTIONS

For the protection of retailers abiding by the Fair Trade Laws, the Corning Glass Works, Corning, N. Y., is continuing its active aggression against consistent violators. Twelve new injunctions have been issued against retailers by the Supreme Court of Steuben County of the State of New York.

These injunctions permanently restrain and enjoin the retailers from advertising, offering for sale, or selling the products of the Corning Housewares Division, bearing the Pyrex trade-mark, at less than prices stipulated under the Fair Trade Agreements. In each of these cases the courts awarded Corning judgment with costs.

This makes a total of 77 such injunctions obtained by Corning against retailers for continuing to ignore the minimum Fair Trade prices on Pyrex brand ware.

FORD TANK DOWN AFTER 2½ YEARS

An Associated Press dispatch reveals that a 100 ton tank in the Ford Motor Company's glass plant at Dearborn, Mich., was closed down for repairs September 23 after having poured a 51 inch wide sheet of glass without interruption for approximately two and one-half years.

A Ford Company statistician figured that if the glass strip could have been laid out in a straight line it would have measured 2,854 miles. The total weight of the glass output during the long run that began March 29, 1939, was 70,375 tons. The previous record for the continuous glass pouring was 159 days, also established by the Ford Glass plant.

Aplite

This new material for incorporating ALUMINA in glass at lower cost is providing excellent results.

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Cleveland Tramrail cab-operated tractor unit pushing a train of five loaded batch buckets into position at electrical pusher of No. 3 furnace. The batch is unloaded into the doghouse by the teaser who operates the pusher by means of control on furnace-floor level.

For the highest quality milk-bottle glass, the ingredients must be held to exact proportions at all times.

To assure no variation in the mix, the progressive Thatcher Manufacturing Company installed a Cleveland Tramrail batch-handling system. This eliminates segregation difficulties and assures uniformity day in and day out.

Thatcher milk bottles are consistently alike. The great strength and pertinent features of any one bottle will be found in every other bottle. As a result, Thatcher customers get bottles that are always up to specifications.

Cleveland Tramrail equipment has been developed for many plants for handling batch materials to furnaces requiring from 60 tons to 1200 tons in a 24-hour period. Automatic, semi-automatic, and simple hand-propelled systems are in use.

If you are interested in securing higher quality, consistently uniform glass, we invite your inquiry.

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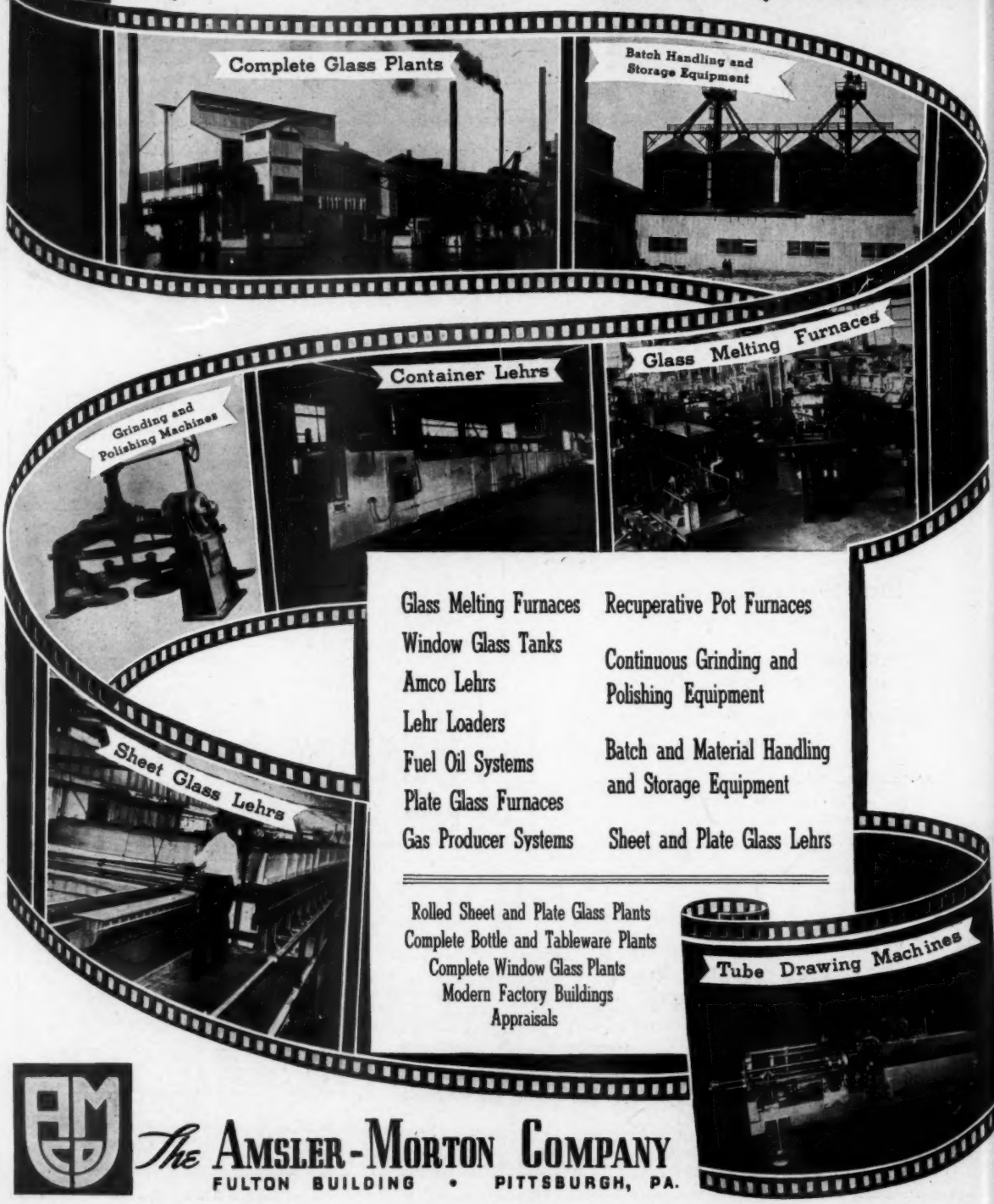

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